MACHINERY.

August, 1906.

THE LUSITANIA.

The launching of the new Cunard express steamer *Lusitania* at Clydebank on June 7 last, marks an era in the development of the ocean steamship. Not only has this vessel the greatest tonnage of any yet built or planned, but it is to be the swiftest vessel in the world, outside of the destroyer class, and is to be driven by steam turbines in units larger by far than any that have previously been designed. These engines will develop 70,000 horsepower, an increase of 70 per cent over that developed by the largest and fastest steamer now afloat. This great power is applied to quadruple screws, still another innovation in steamship design. Considerations of national pride were largely instrumental in deciding upon the building of the *Lusitania* and her sister ship, the *Mauritania*. English vessels had held the supremacy for speed up to about nine years ago. At that time the Hamburg-American Line, with the encouragement and assistance of the German government, built and put in commission the *Kaiser Wilhelm II.*, the fastest of a series of large and powerful vessels which have ruled the seas from that time to this. This increase in power and speed of the German boats, coupled with the absorption of a number of the English lines by the American capital of the "steamship trust," led to the belief on the part of the British government that their marine supremacy was endangered, and that there would come a time when the Admiralty would be handicapped in time of war by a lack of the merchant flyers on which they have been accustomed to depend in making their estimates of the nation's naval strength. Thus national pride and national safety combined to urge the government to assist the Cunard Co. in the building of these two 25-knot steamers.

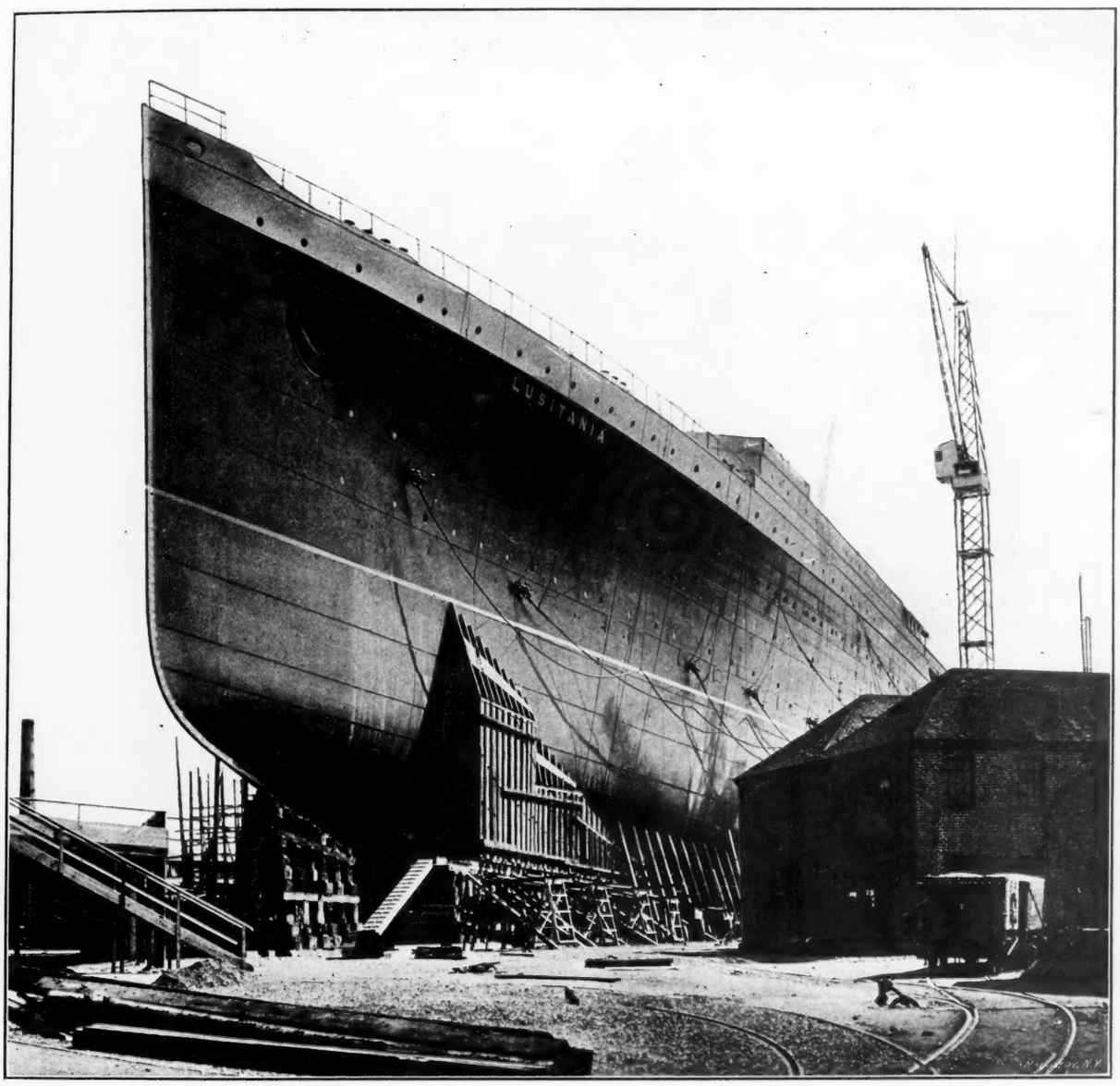


Fig. 1. Bow View of the "Lusitania," on the Ways Ready for Launching.

Sir Andrew White, naval architect, who had a large share in determining the design of the new vessels, in a recent letter to the *London Times* has described the thorough and painstaking way in which decisions were reached on the engineering questions involved. The main considerations were that these vessels should be "capable of maintaining a *minimum*

average ocean speed of from 24 to 25 knots in moderate weather." On this condition depended the payment of an annual subsidy from the government, and important financial arrangements in regard to raising the necessary capital. The idea that the vessels were to be available as powerful cruisers in time of war was also a determining factor in planning their equipment. With these points in mind, and with the tonnage of the vessels determined, the best engineering ability of the country was employed in outlining the design. No unusual steps were taken without first carrying out exhaustive experiments to determine their feasibility. These experimental inquiries were combined with scientific calculations, and every precaution was taken to obtain the best results as regards form, dimensions, economical propulsion, strength, stability, good behavior, passenger accommodation, and efficient working of the propelling apparatus. Proposed models for the hull were tried out in the model tank of the Admiralty at Haslar and at the works of the builders.

When the question of deciding on the type of motive power and propelling apparatus was reached, the directors of the Cunard Co. appointed a special committee for the purpose of considering and reporting on the possible adoption of turbine machinery. The committee included representatives of the Cunard Co., the Admiralty, Lloyd's, and the firms who were to build the boats. A member of Messrs. Denney & Co., who have had exceptional experience in the construction of turbine steamships, also gave his services in the discussion of this question. Mr. Parsons and his staff prepared the designs which were submitted to the committee.

To obtain the increase of speed from the 23½ knots of the fastest German liner to the 25 knots proposed for these vessels, required a much greater proportional increase in power plant than that required in passing from 22 to 23½ knots. It was discovered that the increase of engine power, as noted in the introductory paragraph, would have to be about 70 per cent over that of the *Kaiser Wilhelm II.*, with a corresponding increase in the coal consumption and coal storage space. In considering the adoption of reciprocating engines it was found that triple screws and three sets of machinery would be necessary, and that each set would have to be of much greater power than any engines previously built. One unit would have had to be set behind the other two. With engines of large power set so far aft, even with the most careful balancing, there would be risk of objectionable and dangerous vibration. Besides this, the making of the propeller and crank shafts would involve great difficulties, as they would be heavier than anything hitherto attempted. After making trials of two sister ships built by Messrs. Denney & Co., of which one was fitted with turbines and the other with reciprocating engines, the results were so favorable to the turbines, and this form of apparatus gave so complete a solution to the problem just outlined, that it was finally determined to use this new type of apparatus even though it involved an increase in power of nearly five times that of the largest engines of this type previously built. This abrupt increase in power was practically as great as the total advance made gradually with reciprocating engines in the past forty or fifty years, yet the committee has perfect confidence that the design as finally approved will be a practicable one, since every feature has been so carefully studied that in no detail can these engines be said to involve experimental or undetermined factors. The advantages it is expected to gain by the use of the turbine are: Freedom from vibration; reduced cost of maintenance and working expense; greater economy in the use of steam at or near the maximum power; capacity to run continuously for long periods without sensible deterioration in condition; and power to take considerable overloads without injury. The available evidence also shows that the turbine tends to increase in economy with increase in size and power.

In Fig. 1 is shown a view of the bow of the *Lusitania* as she appeared on the ways in the shipyard of Messrs. John Brown & Co., just previous to the launching. The great size of the hull is realized on comparing it with the buildings that stand beside it. The hull is 785 feet long over all, with an extreme breadth of 88 feet and a depth of 60½ feet. This proportion of length to breadth is not so great as in other recently designed trans-Atlantic steamers. The water-line length of the *Lucania* is 9.2 times the beam; of the *Oceanic*, 10 times the beam; of the *Kaiser Wilhelm II.*, 9.5; while that of the new Cunarders will be only 8.6 times the beam. This great length with greater proportionate beam, favors economical propulsion at maximum speed. Her lines gradually widen out to the full beam, and from this point fall away again to the stern, thus giving no continuance of the greatest width on the water line. She is thus all " entrance" and "run". A notable increase in proportionate depth has been made, which favors the longitudinal strength of the vessel when exposed to the vertical bending action of Atlantic storm waves. The proportion of length to depth is about 12.6 as compared with 13 and 14 for other large and fast vessels.

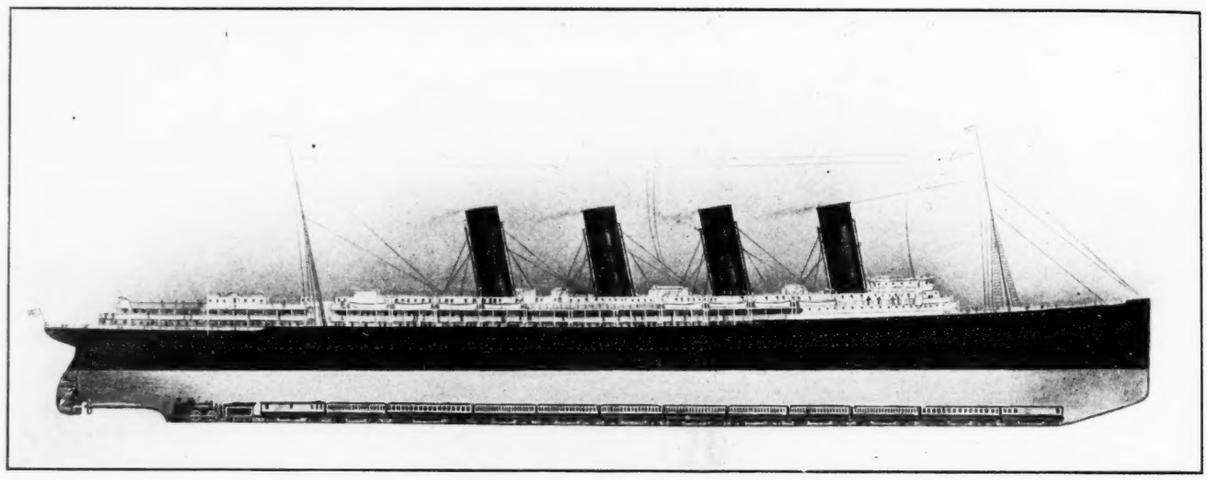


Fig. 2. Comparative Lengths of the "Lusitania" and the "Cunard Special" Express.

The keel is about five feet high and one inch thick, and does not project through the bottom of the hull. This keel, together with the numerous transverse frames, divides the double bottom into compartments in which water ballast may be carried. The tops of these tanks are carried well beyond the turn of the bilge so that any injury to the hull due to collision below water line or grounding, will be confined between the inner and outer bottoms. Bilge keels are provided to insure steadiness of behavior. The lower deck is made completely water tight. Below it are the lower orlop and orlop decks and above it are the main, upper, shelter, promenade, and boat decks, nine decks in all; the decks below the water line are all divided into water-tight compartments which may be closed by bulkhead doors of special design, operated automatically from the bridge. The vessel will have in all 175 water-tight compartments thus protected.

There are 25 boilers of the usual cylindrical or Scotch type, all but two of which are double-ended. The steam pressure is about 200 pounds per square inch. There will be four funnels 24 feet in diameter, with tops 155 feet about the keel. The fur-

naces will consume about 1,000 tons of coal per 24 hours during the transatlantic passage and great care has been taken in arranging the coal bunkers so that this great weight may be handled with economy of time and labor. The question of oil fuel was considered and if it had been possible to obtain a reliable supply of a suitable fuel of this kind, the problem of handling and storing fuel would have been greatly simplified. If it is warranted in the future, however, the change from coal bunkers to oil tanks can be readily made. Electricity will be largely used for the lighting, ventilation, operation of elevators and other auxiliary purposes. The current will be generated by steam turbines instead of the reciprocating engines usually employed.

As already mentioned, the motive power is divided into four units, each of which has its own propeller shaft and propeller. The two outer shafts carry the high pressure turbines, the inner shafts the low-pressure and backing turbines, thus making six in all, four for forward and two for backward motion. The shafts and rotor drums for these engines are of immense size and strength and were forged at the Atlas Works of the builders at Sheffield. The longest blades on the low-pressure rotor, those at the exhaust end of the machine, are 20 inches in length. The speed at the periphery of the circle formed by the blades ranges from 100 to nearly 150 feet per second. The casings and blades for one of the low-pressure turbines weigh about 450 tons complete. The placing of the propellers was a new problem and one determined only after considerable investigation and experiment; as built, the high-pressure pair are located about 80 feet forward of the low-pressure propellers, and are carried by long, tapering tubes which support them at quite a distance from the sides of the hull. In the general arrangement of the propelling machinery the Cunard Co. has been greatly assisted by its experience in the building and operation of the *Carmania* and the comparison of the performance of that vessel with her sister ship, the *Coronia*, which is fitted with reciprocating engines.

It has been mentioned that the vessel was designed with a view to being used as a cruiser in time of war. For this purpose her coal bunkers have been so arranged as to protect the vital parts of the machinery. The rudder and its supporting framework is entirely below the water line, and is provided with two sets of steering gear, one of which is also below the water line. Provision has been made in the framing and deck arrangements of the vessel for the housing of twelve 6-inch guns, which will compose the offensive armament.

The great length and draft of the vessel necessitated unusual preparations for her launching. The keel was laid down in such a direction that the hull took the water at the widest available point, giving not only the width of the River Clyde itself but a considerable space in the mouth of a tributarial stream, the Cart, which flows in at this point. Dredges have been constantly at work for a number of months to make ready a launching channel for the big vessel. To bring her to a stop within the length of run which it was possible to provide, sixteen masses of chain cable were used to check the momentum after launching; each pile of cable weighed one hundred tons. As the vessel slid down the ways into the water these chains, connected to the hull by wire cables, came into action pair by pair until five pair finally stopped her career, the last of them being scarcely tightened. The launching weight of 16,000 tons was by far the heaviest weight ever carried upon the launching ways of any shipyard, but the operation was effected without difficulty and without danger. It will probably be a year or more before the *Lusitania* will be in commission

Perhaps a comparison will serve to convey a clearer idea of the immense size of this largest and fastest of all ocean steamers. Fig. 2 shows the "Cunard Special" express train which runs between London and the landing stage of the steamship company in Liverpool. This train, with its powerful engine, tender, two baggage cars, two dining cars and eight coaches, is fully 100 feet shorter than the *Lusitania*. The funnels will be 155 feet, and the tops of the masts 216 feet above the keel. The gross tonnage of the vessel is 32,500, while her displacement, when filled with her cargo, will be fully 45,000 tons.

BRAKES.—1.

C. F. BLAKE.

The duty of a brake applied to machinery is to absorb energy by creating frictional resistance, which must transform into equivalent heat a certain number of foot-pounds of energy in a given time.

This leads at once to an important function of any brake, often overlooked; it must be designed to convey away the heat as rapidly as possible by conduction, radiation and convection by the air. This means that the friction must be distributed over a sufficient area to prevent undue heating of the parts for the material of which they are made.

The most severe duty exacted of crane brakes is found in traveling cranes, where the brake is often called upon at such frequent intervals as to allow a minimum time between for cooling. Indeed, these brakes often run for long periods at temperatures exceeding that of the atmosphere.

Brakes with wood friction blocks on iron drums give satisfactory service if one square inch of friction surface is allowed for each 200 or 250 foot-pounds of energy absorbed. Car brakes, on the other hand, running with iron on iron under conditions very favorable to quick cooling, are often called upon to absorb as much as 10,000 to 15,000 foot-pounds of energy per square inch of friction surface. Figures for other types of brakes will lie between these extremes.

It has been the practice with some designers to provide a ribbed exterior to the casing of block brakes, and also to use thin ribs or vanes on the brake drum to provide radiating surface. It is also customary to leave all radiating surfaces rough and black, since a finished or polished surface confines the heat instead of radiating it into the atmosphere. The location of the brake on the crane is also of importance in regard to cooling, since if placed in a protected position it will not cool as rapidly as if more exposed to the air currents.

The mechanical equivalent of the heat required to raise one pound of water through one degree Fahr. is 778 foot-pounds of energy. Kent, page 475, quoting Box on Heat, gives values for the heat units radiated per hour per square foot for each degree Fahr. rise in temperature; and these figures reduced to square inches per minute per degree rise in temperature are:

Cast iron, new	0.000075
Cast iron and sheet steel, rusted	0.000079
Sheet iron, polished	0.0000106
Sheet iron, ordinary	0.000066
Wood	0.000085

The equivalent foot-pounds of energy radiated are these figures multiplied by the mechanical equivalent 778, giving us the radiation constants R for

Cast iron, new	0.058
Cast iron and sheet steel, rusted	0.061
Sheet iron, polished	0.0082
Sheet iron, ordinary	0.051
Wood	0.066

R

which latter figures are the foot-pounds of energy radiated per square inch of surface per minute per degree rise in temperature, according to Newton's law of cooling, which is that the radiation is proportional to the difference in temperature $(t_1 - t)$ between the radiating body and the air.

This law has been proved incorrect beyond the limits of a difference in temperatures of thirty degrees, with the atmosphere not higher than sixty degrees Fahr. Kent gives the following table as computed by Box, for correcting the radiation constant R beyond these limits.

TABLE I. CORRECTION FOR RADIATION CONSTANT.

$t_1 - t$ Fahr.	Temperature of the Air t.				
	32	50	59	68	86
18	1.00	1.07	1.12	1.16	1.25
36	1.03	1.08	1.16	1.21	1.30
54	1.07	1.16	1.20	1.25	1.35
72	1.12	1.20	1.25	1.30	1.40
90	1.16	1.25	1.31	1.36	1.46
108	1.21	1.31	1.36	1.42	1.52
126	1.26	1.36	1.42	1.48	1.60

The loss by convection appears to be independent of the material of the heated body, but varies with its shape and location, and for any given conditions is nearly proportional to the temperature difference. This proportion, however, like that for radiation, needs adjustment beyond narrow limits, and Kent presents a table similar to the above for convection losses; but the extreme variation in shape and location, in the case of brakes, leaves the designer so few data as to render the table practically useless for this purpose. The best values obtainable for convection losses indicate that they may be taken at about three quarters of the radiation losses, making the total loss 1.75 × the loss by radiation.

The specific heat, or more properly, the coefficient of thermal capacity, of various materials used as friction surfaces in brake construction, compared to water as unity, is as follows:

Brass, 0.094
Wrought iron, 0.114
Cast iron, 0.130
Steel, 0.117

The foot-pounds of energy required to raise one pound of these materials one degree Fahr. is then, 778 × the specific heat, which gives for

Brass, 73
Wrought iron, 88
Cast iron, 101
Steel, 91

These values we will designate by c.

With wood or leather blocks 150 degrees Fahr. is set as a limit if charring of the blocks is to be avoided, while with metal friction blocks the temperature is limited by the ability of the parts, especially the drum, to withstand the accompanying expansion without cracking. To aid the drum in this respect the web or arms are often made dished, which gives them a slight elasticity, enough to accommodate the expansion of the drum under the confining influence of the blocks.

The arms and hub of the brake drum are so remote from the friction surface as to acquire heat by conduction very slowly, and this source of loss may be neglected.

Let

W = the weight of the brake drum rim in pounds,
c = foot-pounds of energy required to raise one pound one degree Fahr. (values given above)
R = radiation constant (values as given above. Use $1.75R$ to allow for convection)
A = the area of the radiating surface, in square inches.
n = the number of minutes elapsing between the applications of the brake,
t_1 = the maximum temperature of brake drum at moment of attaining rest, Fahr.
t = the minimum temperature of brake drum, after cooling from t_1 for n minutes, Fahr.
E = foot-pounds of energy to be absorbed at the brake.

We then have (see *A Laboratory Manual of Physics*, by Prof. E. L. Nichols)

$$\log\ (t_1 - t) = \frac{0.437\, n\, R\, A}{W\, c} \qquad (1)$$

from which, by a table of logarithms, the value of $t_1 - t$ may be found.

Now $t_1 - t$ is the raise in temperature, so

$(t_1 - t)c$ = foot-pounds absorbed in raising one pound from t to t_1 degrees Fahr.

But we have a total of W pounds, so the total foot-pounds absorbed is,

$$E = (t_1 - t)\, c\, W \qquad (2)$$

Therefore,

$$t_1{}^{\circ} = \frac{E + t\, c\, W}{c\, W} \qquad (3)$$

and,

$$(t_1 - t) = \frac{E}{c\, W} \qquad (4)$$

By these formulas the performance of a given brake as regards heating may be approximately determined, but as will be observed, much is left to the judgment of the designer in their use.

Classes of Brakes.

Crane brakes are usually found to be in one of three classes:

I. Band brakes, consisting of a flexible band wrapped around the periphery of a drum;

II. Block brakes, consisting of arms carrying blocks arranged to clamp the drum between them;

III. A third class, which from the method of application should be called axial brakes, since they are applied in a direction parallel to the shaft, but which are variously spoken of as friction brakes, load brakes, safety brakes, automatic brakes, and mechanical brakes.

Brakes of this class are usually designed so that the retarding torque is directly proportional to the load sustained, and are most largely used on electric and hand cranes for the automatic sustaining of the load should the power fail. We, therefore, prefer the name automatic brake for this class, although this must not be assumed to mean that either of the other two classes of brakes cannot be made to act automatically under certain conditions.

Brakes of the first two classes present no great difficulties to the designer, but of the third class, automatic brakes, it may be said that there is perhaps no part of the modern crane offering the difficulties presented by this mechanism.

The variation of the coefficient of friction under varying conditions of load, speed, temperature, lubricants, materials and finish of friction surfaces, compels at the start an assumption that may be more or less wide of the mark. Other conditions, more or less important according to the design of the brake, are the action of centrifugal force, the unequal wear of the friction surfaces, the expansion and contraction due to heating and changes of atmospheric temperature. All these ren-

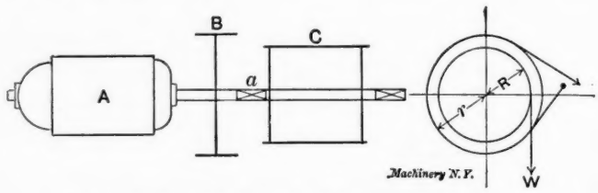


Fig. 1. Simple Problem in Finding Kinetic Energy.

der the final performance of a given brake so much a matter of conjecture that it is unwise to depend upon calculations in this regard.

All such brakes should be designed as far as possible with facilities for changing conditions, such as altering the diameter or number of the friction discs, changing the pitch of the helix or thrust screw, as experiment with the completed brake may direct.

A thorough investigation of the behavior of these brakes is much needed, and offers an interesting and profitable field for thesis work in some well-equipped mechanical laboratory. Lacking such investigation, the designer, working out an occasional brake, should provide ample facilities for such final changes as the test load behavior of the brake may suggest.

In designing a set of brakes for a line of cranes of varying capacities, an experimental brake should be made and tested, changes being instituted until the test behavior of the brake is satisfactory, and the entire set of brakes carefully proportioned from these data. Even this procedure is not entirely satisfactory. A set of brakes was thus designed by a manufacturing company for a line of cranes ranging from three to seventy-five tons capacity, and all were found to work satisfactorily with the exception of two. Upon examining these for differences or irregularities in their proportions, as deduced from the experimental brake, none were found, and their peculiar behavior could only be charged to the uncertainty of the many varying factors.

Formulas (1) to (4) require that the kinetic energy to be absorbed by the brake be known, and this is made up of four factors: the energies of the live load; of the rotating parts; of the parts having a motion of translation; and the energy preventing acceleration.

Let us consider first the energy of the live load and that preventing acceleration. Let Fig. 1 represent an elementary crane consisting of motor A, brake B, and drum C, all mounted upon a single shaft. Let it be assumed that the brake is

so proportioned as to just hold the suspended load in equilibrium. Then the suspended load possesses potential energy, and the tangential force or friction at the brake drum rim required to hold the load is

$$F = \frac{W R}{r}$$

if we, for the time, neglect all frictional losses.

Let n = the revolutions per minute of the motor. Then if the motor be started in the lowering direction, the velocity V of the descending load will be known, since by reason of our assumption, the brake prevents acceleration. Hence,

$$V = \frac{2 \pi R n}{60 \times 12}$$

feet per second, if R is in inches.

The energy of the descending load is then,

$$E = \frac{W V^2}{2 g} \qquad (5)$$

g being 32.2.

If the load were to be lowered free, and unrestrained by any brake it would obey the laws of gravitation, and, overhauling the motor, would descend with a constantly accelerating velocity. It therefore follows that there is work done in overcoming this acceleration and confining the load to a constant velocity, and that this work is done by the brake, and is represented by the friction times the relative velocity of the frictional surfaces. Usually one friction surface is at rest, and the relative velocity becomes the velocity of the other.

TABLE II. PROPERTIES OF BODIES OF ROTATION.

	VOLUME	k^2
1	$\frac{\pi}{4} d^2 L$	$\frac{d^2}{8}$
2	$\frac{\pi}{4} L (D^2 - d^2)$	$\frac{D^2 - d^2}{8}$
3	$\frac{\pi}{12} L (D^2 + D d + d^2)$	$\frac{3}{10}\left(\frac{R^5 - r^5}{R^3 - r^3}\right)$
4	$\frac{\pi d^3}{6}$	$\frac{d^2}{10}$
5	$a d L$	$\frac{a^2}{12} + \frac{l^2}{3}$
6	$\frac{\pi}{4} d^2 L$	$\frac{d^2}{16} + \frac{l^2}{3}$
7	$\frac{\pi}{4} D d L$	$\frac{D^2}{16} + \frac{l^2}{3}$
8	$a d L$	k^2 (from 5) $+ x^2$ $\frac{d^2}{12} + \frac{h^2 + h h^1 + (h^1)^2}{3}$
9	$\frac{\pi}{4} d^2 L$	k^2 (from 6) $+ x^2$ $\frac{d^2}{16} + \frac{h^2 + h h^1 + (h^1)^2}{3}$
10	$\frac{\pi}{4} D d L$	k^2 (from 7) $+ x^2$ $\frac{d^2}{16} + \frac{h^2 + h h^1 + (h^1)^2}{3}$

Machinery N.Y.

This velocity is,

$$V' = \frac{2 \pi r \hat{n}}{60 \times 12} \text{ feet per second,}$$

and the kinetic energy is,

$$E_a = \frac{F (V')^2}{2 g} \qquad (6)$$

in which F = the friction at the brake wheel rim.

In bringing the load to rest upon shutting down the motor, the brake is called upon not only to absorb or turn into equivalent heat the kinetic energy from these two sources, but also

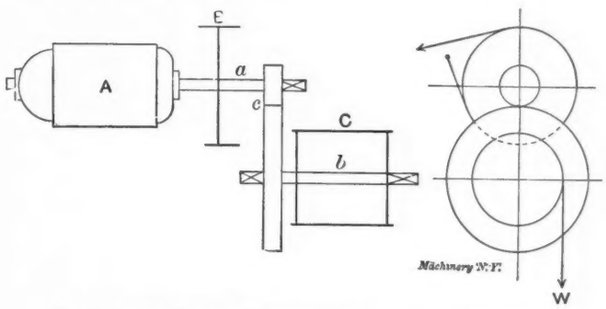


Fig. 2. Finding Energy of Rotating Parts, including Gear Train.

the kinetic energy of all rotating parts, since these must also be brought to rest.

The kinetic energy of a revolving body is,

$$E_r = \frac{2 \pi^2 \left(\frac{n}{60}\right)^2 k^2 W'}{g} = \frac{W' \pi^2 n^2 k^2}{1800 g} \qquad (7)$$

in which,

n = rev. per minute of the motor,

W' = weight of revolving parts, in pounds.

k = radius of gyration of body in feet, about axis of rotation.

The following table gives the properties of different elementary bodies, and in order to arrive at a value for E_r, we must divide each body of rotation on the shaft into some one or more of these elementary bodies, and finding the kinetic energy of each such elementary body by (7), take their sum as a value for E_r.

In dividing several rotating bodies into their elements for use as above, a drum, for instance, may be considered as made up of case (2) for the shell, flanges and hubs, and case (8), (9) or (10) for each arm, according to the shape. In this manner any complex rotating body may be divided, and its kinetic energy approximately determined.

In Fig. 1, there is no motion of translation, but this is often present in the shape of a moving trolley, bridge or portable crane. It is most frequently unaccompanied by the hoisting or lowering of the load, although in rare cases one brake may be used to bring to rest both a lowering load and a moving trolley.

The kinetic energy of a body having motion of translation is,

$$E_t = \frac{W'' (V'')^2}{2 g} \qquad (8)$$

where W'' = the weight of the body in pounds,

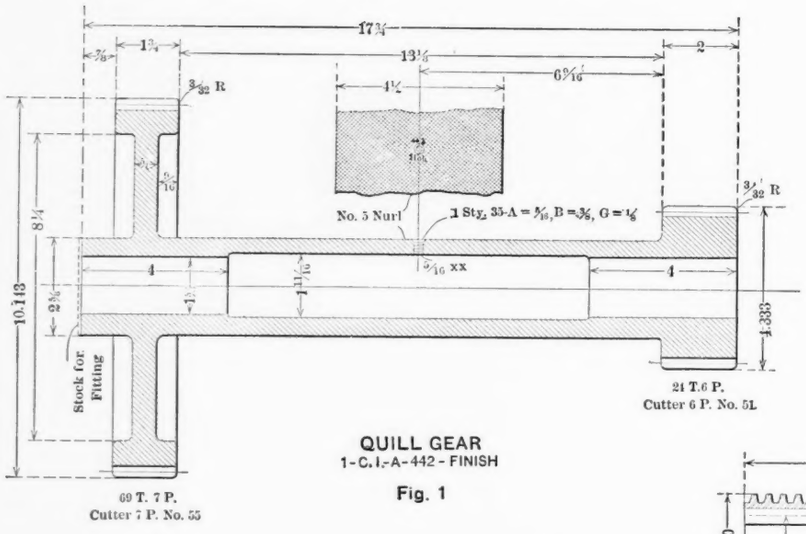
V'' = its velocity in feet per second.

Thus in Fig. 1, the total kinetic energy to be absorbed by the brake is,

$$E_{\text{total}} = E + E_a + E_r. \qquad (9)$$

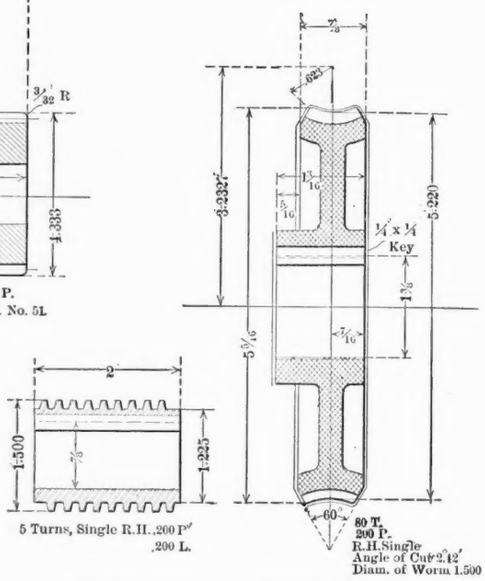
and in calculating the value of E_r, the motor armature, shaft, brake drum, and hoist drum are considered.

While Fig. 1 makes a good illustration of the above principles, it still leaves unconsidered the effect of internal frictional resistances in the machine, which, by absorbing a certain amount of energy, relieve the brake of a portion of its work. In other words, the total kinetic energy E_{total} is not absorbed by the brake, but only a portion $e E_{\text{total}}$, where e is a decimal, the remainder being absorbed by the internal fric-



QUILL GEAR
1-C.I.-A-442 - FINISH

Fig. 1



WORM
1-M.S:C. H.

WORM WHEEL
1-G.M. F-2-A
13

Fig. 5

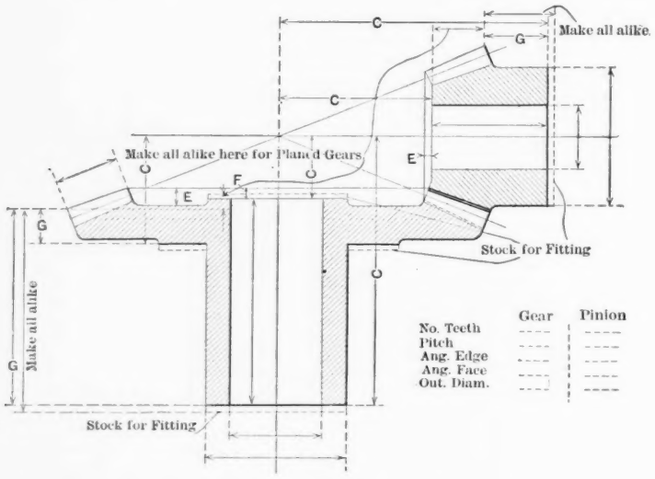
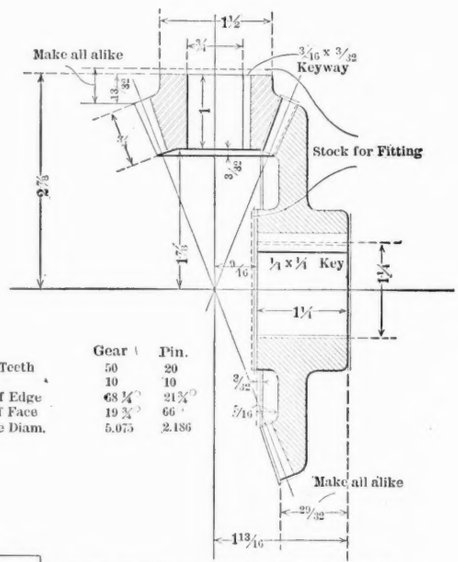


Figure E and F as near as can be measured easily on the drawing.
If rough on end of Hub and front of Gear give only one dimension
Figure C to either the outside or inside Hub of Gear to check with other details.
Never give but one dimension C for the same Gear.
Figure G to the nearest even figure not finer than 1/32. Give figure to the Shoulder that is worked from. Give but one dimension G for same Gear.
Leave Stock for fitting only at Shoulders when required and indicate as shown on drawing.
In giving Angles give nearest ½ degrees.

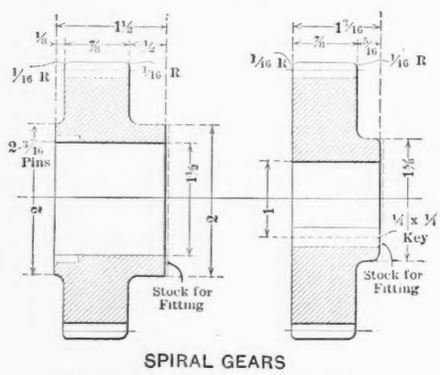
Fig. 3



HAND ELEVATING BEVEL GEAR AND PINION

1-C.I. P-5 193 1-M.S.

Fig. 2



SPIRAL GEARS

DRIVEN
1-C.I. A-B-3 8 FINISH

DRIVING
1-C.I. A-B-3 7 FINISH

Fig. 4

Data for Spiral Gears		
No. of Teeth	L.H.	28
Pitch Diameter		2.5
Outside Diameter		3.6767
Circular Pitch		.3927
Angle of Teeth with Axis		15°
Normal Circular Pitch		.2776
Pitch of Cutter		11.313
Addendum		.0883
Thickness of Tooth		.139
Whole Depth		.190
No. of Cutter		4
Exact Lead of Spiral		10.995
Approximate Lead of Spiral		10.997
Gears to Cut Spiral		
Gear on Worm		15
1st Gear on Stud		26
2nd Gear on Stud		61
Gear on Screw		96

Examples of Methods of Dimensioning, taken from Brown & Sharpe Gear Drawings.

Machinery N. Y.

tional resistances. Therefore instead of (9) we should have,

$$E_{\text{total}} = e\,E + e'\,E_a + e''\,E_r$$

where e, e', e'' represent the per cent of efficiency of the mechanism between the moving parts giving rise to E, E_a and E_r respectively, and the brake.

Thus in Fig. 2, where we have a gear train introduced between the brake and the load drum, we would have for the several kinetic energies to be absorbed by the brake the following:

1.—eE for the load W, in which E is from (5) and e is the efficiency of the entire mechanism, including ropes, shaft b in its bearings, gears c, and shaft a in its bearings.

2.—$e'\,E_r$ for the rotating parts, drum and gear, on shaft b, in which E_r is from (7), and e' is the efficiency of shaft b

in its bearings, the gears c, and the shaft a in its bearings.

3.—$e''E'_r$ for the rotating parts, armature, brake drum, and pinion on shaft a, in which E'_r is from (7) and e'' is the efficiency of the shaft a in its bearings.

4.—E_a from (6).

In one of the data sheets for March, 1903, was a convenient chart for the solution of the holding power and tensions in the band brake. This chart applied to flat-faced brake wheels only, and since the V-grooved brake wheel is often met with, we must find the increased holding power due to the wedging of the blocks into the V-groove. Formulas for the latter type of brake wheel were derived in an article by the writer in MACHINERY for March, 1905, as follows:

Let N = normal pressure on a flat-faced wheel.

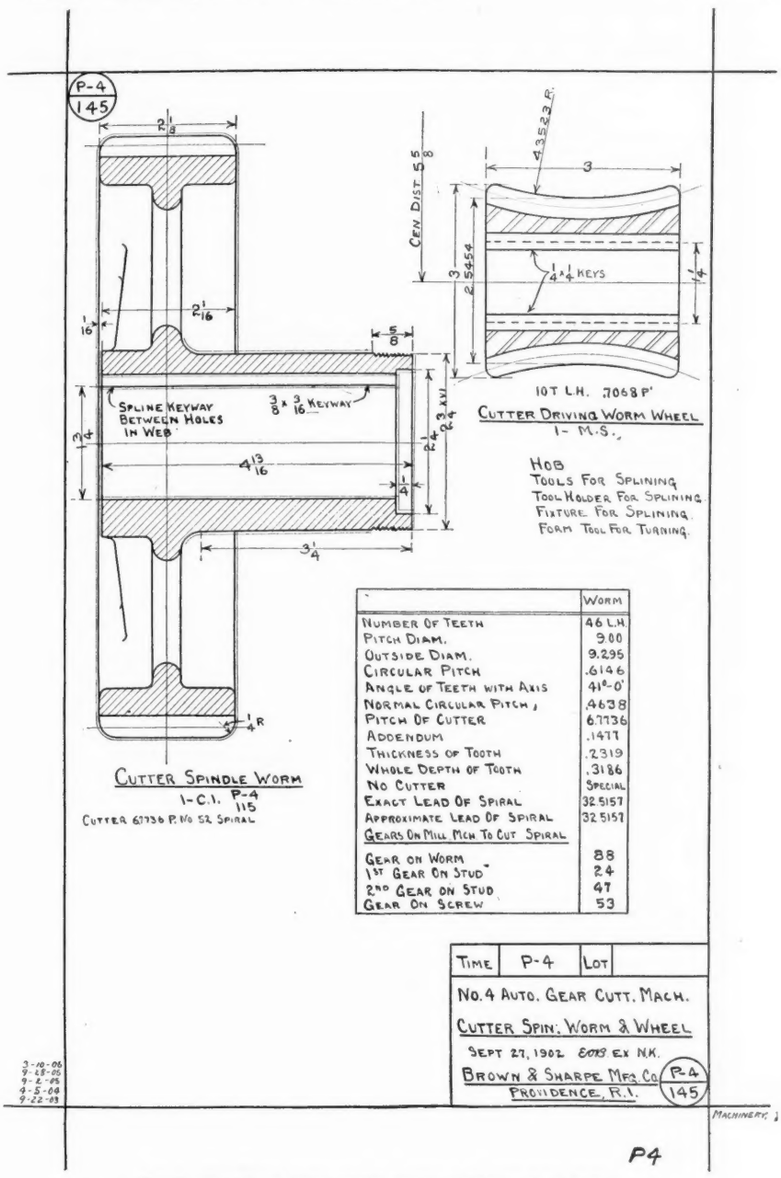


Fig. 6. The Worm Drive of the Brown & Sharpe Gear Cutter.

n = normal pressure on one side of a V-grooved wheel.
$2n$ = total normal pressure on a V-grooved wheel.
P = tangential force for a flat-faced wheel.
P_1 = tangential force for a V-grooved wheel.
a = half the included angle of the groove.

Then

$$2n = \frac{N}{\sin a}$$

$$P_1 = P \text{ cosec } a.$$

In the article referred to above are illustrations of several types of band brakes, with a calculation worked out for the holding power, to which the reader interested in the subject is referred.

THE FIGURING OF GEAR DRAWINGS.

L. D. BURLINGAME.

We have found constant trouble both in our own drafting department and in the case of drawings sent to us from customers, in the methods, or lack of methods, employed in figuring gear drawings. This has led to the establishment of a standard method of figuring, which meets the requirements of our shop and which has been modified from time to time to give the required information in the best possible form. At the suggestion of the editor, I am sending a number of samples showing the method employed by us, and these drawings also illustrate a number of other points of our established drafting room practice.

In the simplest case, that of the spur gear, the number of teeth and the pitch, with the outside diameter, give the important data as far as the cutting of the teeth is concerned. Where a special cutter is used it is numbered and called for on the drawing, so that the cutter can be quickly selected when the gear is to be cut, thus avoiding the possibility of a mistake. It will also be noticed that the corners of the teeth are rounded; this is to give a neater appearance to the gear and make it better in handling, a point that applies especially to change gears. It will be noticed that no inch marks are used on this drawing as all of our figures are in inches.

Fig. 2 illustrates an ordinary case of a pair of bevel gears. We choose to give the angles and the outside diameter in tabular form to avoid confusion on the drawing. It will be noticed in this and other cases that stock is allowed for fitting where required and this is indicated on the drawing. The object of making all the blanks alike in the dimension specified is to avoid resetting in the gear-cutting machine when carrying through a lot of gears. No. 3 gives further particulars as to the plan on which bevel gears are figured and some of the reasons for same. This drawing is in the reference book at every man's desk, and gives him the instructions required for figuring, so that all of our work may be uniform.

Fig. 4 shows a pair of spiral gears. The data here is arranged and tabulated as specified in Brown & Sharpe's "Formulas in Gearing," which contain formulas for all of these calculations and a copy of which is also at every draftsman's table. Our practice in figuring keys is indicated here, the key being shown in position in the piece where it is tight. If the key were tight in the shaft, the keyway only would be shown in the drawing of the gear.

Fig. 5 shows the worm and worm wheel. This indicates our method of showing finish, the finish lines being indicated by a red line against the surfaces that are machined. This shows on the blueprint as a fainter line and has been used by us for many years in preference to the "f" or other symbol ordinarily used. This is some additional expense, as we re-line these with prepared red on the blueprint, but we consider it justified for our work. It will be noticed that the distance between centers of the worm and wheel is figured. It will also be noted that the end of the worm is turned down to a diameter corresponding to the bottom diameter of the thread, this serving as a guide for depth in threading the worm.

Fig. 6 illustrates a worm and wheel in which the worm is much larger than the worm wheel, an unusual condition. In this case the worm is cut with a cutter more in the manner of a spiral gear, while the worm wheel is hobbed. This sheet will illustrate our method of titling our drawings. The figures showing faintly at the lower left-hand corner indicate the

dates that blueprints have been made from this sheet. The numbers in the circles in the corners give, above, the symbol number of the machine, with the consecutive sheet number below.

Besides these gears shown, there are coming up in our regular work cases of intermittent gears, internal gears, racks and pinions, and special data required for planed bevel gears, all of which have to be figured in a systematic manner.

[Perhaps it might be well to call attention to a few additional points suggested by the drawings Mr. Burlingame has sent us. In Fig. 1, which shows a quill gear for a milling machine, it will be noted that under the gear is marked the symbol "69 T. 7 P.," while under the pinion is marked "24 T. 6 P." This means, of course, that there are 69 and 24 teeth, respectively, in these gears, and that they are cut with a 7-pitch and a 6-pitch cutter. Although it is aside from the question under discussion, it is interesting to note the fact that the center of the body of the quill gear is represented as being knurled with a "No. 5" knurl. Standard pitches for knurling have been adopted by this firm, samples of which are on exhibition in the drafting room, where they can be referred to as often as necessary. In the bevel gear drawings, Figs. 2 and 3, it will be noted that the edge and face angles are measured from a line perpendicular to the axis of the gear. This is the most convenient way of dimensioning it for the workman, whether the face and edge are finished with a square-nose tool or turned with the compound rest. In the one case the faceplate surface is the plane of reference, and a protractor may be directly applied to it for setting the tool. If the gear, on the other hand, is so large that the face has to be turned, the graduations on the compound rests of most lathes are such as to give readings corresponding to this method of dimensioning.

In the table giving the dimensions for spiral gears but one column is given, since the two gears are evidently identical so far as the teeth themselves are concerned. The letters "L. H.," given in the same line with the number of teeth refer, of course, to the fact that they are cut with a left-hand spiral. In the drawing of the worm, ".200 L" means, of course, 0.200 inch lead, while "200′ P" means 0.200 inch circumferential pitch. The distinction made between these two terms lead and pitch would be evident in the case of a double-threaded worm; for instance, if the pitch of such a worm were 0.200 inch the lead would be 0.400 inch, the lead being the linear distance that a tooth advances for every revolution of the worm. The drawing reproduced in Fig. 6 is interesting in that it gives data for one size of the well-known and somewhat peculiar cutter spindle driving gear used on the Brown & Sharpe automatic gear-cutting machine, and is so reproduced as to give some idea of the general drafting room practice of the Brown & Sharpe Mfg. Co. The worm wheel is the driver in this case. In the table, the "exact lead" is that required by the mathematical solution of the problems. The "approximate lead" is that given by the gears listed, which in this case figure out exactly right.

These drawings as a whole are quite suggestive as showing the practice of a firm which cuts a great deal of gearing for outside parties as well as for its own use, and which thus has an opportunity to judge as to the most convenient way of arranging and dimensioning drawings of gears. The point brought out in Figs. 2 and 3, in relation to making the distance from the outside edge of the teeth to the rear end of the hub a constant quantity in all the blanks of a given lot, is an important one and attention to it will save considerable time in the re-setting of the machine when cutting the gears.—EDITOR.]

* * *

THE IMPORTANCE OF CRYSTALLOGRAPHY IN THE STUDY OF MATERIALS OF CONSTRUCTION.

The bearing of crystallography on engineering, says Dr. Fulton in the *Times Engineering Supplement*, is of no trifling character, since the whole of the metallic materials employed by the engineer are crystalline substances. Hundreds of valuable lives have been sacrificed by the existence of flaws in metallic beams, girders, tie-rods, bolts, rails, wheels, and axles, consequent on local development of crystalline structure or on the local separation of crystals of a particular constituent in an alloy or a steel. Many of these might have been saved if we had possessed exact knowledge of the crystallographical character of metals, and of the influence upon it of the various metallurgical and mechanical processes to which steels are subject. The fundamental fact of the science is, that every solid chemical element, whether metallic or non-metallic, and every solid substance of definite chemical composition, be it naturally occurring or artificially prepared (with the exception of the few which have never yet been obtained in the crystalline condition owing to the great viscosity of their solutions or of their molecules when in the state of fusion), has its own definite crystalline form, which is just as much a characteristic feature of the substance, by which it can be identified, as is any one of its chemical or physical properties. This is a statement which it has only quite recently been possible to make with certainty. For it was for a long time thought that the members of the numerous well-known series of analogous chemical compounds (which only differ in containing a different member of a family group of chemical elements as their dominating and generally metallic constituent), were absolutely identical in their crystalline form, and they were consequently classed as "isomorphous." But Prof. P. von Groth, of Munich, has been able to prove, as the result of fifteen years' work, that although the forms are very similar, and although they belong to the same type of symmetry, the angles between their corresponding faces are different, to the extent it may be of only a few minutes of arc, but in some cases by as much as a couple of degrees. Moreover, the amount of the difference is governed by a definite law, which connects the atomic weight of the metal or other dominating (acid-forming) element present with the whole of the properties of the crystals, whether of exterior form, of optical character, or of internal structure. The statement becomes all the more interesting when it is pointed out that the number of types of symmetry, according to which crystals can be formed, is only thirty-two, while the number of crystalline substances is legion. For in spite of this fact it is true that the crystals of no two different substances are precisely alike, either in their exterior form or with regard to their internal properties. They may approximate closely in external shape (although more dissimilar in internal properties) if they are chemically analogous, or they may be very different indeed in all their properties if they are chemically unlike.

* * *

George S. Rice, chief engineer of the Board of Rapid Transit Commissioners, has submitted a report upon ventilating the New York Subway. The present difficulties arise because the heat generated in the operation of trains is not dissipated in a sufficiently rapid manner. To improve the conditions in summer the air must be renewed more frequently, and it must also be cooled. Several Sturtevant fans were installed last summer and served for experimental purposes. No definite plan is recommended for cooling, although Mr. Rice suggests three ways in which it may be accomplished, *viz.*, by evaporation of water, by refrigeration, and by absorbing the heat by disposing relatively cool water throughout the subway in some manner to be determined upon. To renew the air, Mr. Rice recommends the use of exhaust fans and also of automatic ventilators, so constructed that they will only open outward, and the covers balanced so that they will remain closed, except when the interior air pressure is greater than that outside. When a train approaches a ventilator, the air pressure in its vicinity will be increased and there will be an outrush of warm air. Six fan outfits are recommended at a cost of $40,000 for the portion between Columbus Circle and Ninety-sixth Street, where the Subway is much cooler than in the southern end of the system. This apparatus would have the capacity for renewing the air in the Subway once every thirty minutes.

* * *

A novel arrangement is in use by the Philadelphia Rapid Transit Co., Philadelphia, Pa., for the local welding of track joints. This consists of a small foundry cupola carried on a trolley car and supplied with blast from an electric pressure blower.

SPRING SCREW THREADING DIES.

ERIK OBERG.

Erik Oberg.

It is undoubtedly true—whatever the cause may be—that there is, as a rule, a great deal more said in the trade papers about taps than there is about threading dies. The reason for this cannot be that taps are considered any more important to the average shop than are threading dies, but rather that dies are carefully avoided by contributors, because of being so much more difficult to make. It is far more generally known what is necessary to make a good cutting tap than what are the essential points in making a good cutting die. However, the die is used for external thread-cutting just as often as the tap is used to thread the corresponding nut, and for this reason threading dies ought to be given a place equally prominent with taps in the manufacture of shop tools.

At present no threading dies are used to such a great extent as are spring screw threading dies. The increasing importance of automatic screw machines has been the one great factor which has added most to the demand for this class of dies. There is, however, still a great deal to wish for in regard to the manufacture of these dies, and there are a number of suggestions which the writer would call to the attention of those who are interested in the gradual perfection of so universally used a shop tool.

There are in general three main requirements for a threading die. The cut should be nice and clean, the thread should be of a perfect form, and the threaded piece should be of the exact diameter required. In order to obtain this there are several points to be taken into consideration.

In the first place it must be observed that a die with a thread cut perfectly straight or parallel would act exactly the same as a tap without back taper, that is, a tap having the same angle diameter at the shank end as at the point. This question in relation to taps was mentioned in an article in MACHINERY, October, 1905, in connection with the relief of taps. The trouble encountered in using taps made without back taper will also appear in dies made in the same manner. To overcome the difficulties arising, and in order to give to the die a certain amount of back taper, usually called clearance, dies for the market are generally made a certain amount over the size required, and then the size to be cut is obtained by means of an adjusting collar, forcing the prongs of the die down sufficiently to produce the correct diameter required on the piece to be threaded. This will, of course, give the die a certain back taper, the amount of which will depend upon the amount over the actual size the die was originally made. The collar being applied at the front end of the die, it will evidently spring the prongs more at the point, where it is applied, than further up, nearer the solid part of the die. This is the general procedure of making spring screw dies for the market, and we will now analyze the results, and see whether this die fills our three main requirements mentioned above.

The die has ample clearance and will almost invariably produce a smooth, cleancut thread. The size of the thread on the threaded piece can also be exactly correct, as the adjusting collar, usually called clamp collar, can be so adjusted as to give any size wished for within certain limits. The form of the thread, however, will not be perfect, as can readily be seen from the cut, Fig. 1, where the case is shown exaggerated. By bending the prongs inward the thread will evidently not move inward at right angles to the axis of the die, but will move along an arc, thus causing the thread to be of incorrect angle in the piece cut, one side of the thread making an angle of more, and one an angle of less than 30 degrees with the axis.

In order to eliminate this error, and still maintain the necessary back taper or clearance, the correct size should originally be at the front end of the die, and the diameter of the thread in the die should gradually increase backward, that is, the die should be made with back taper from the beginning. On large sizes this is, of course, very easily accomplished by setting the taper bar of the machine where the die is chased out over an amount equal to the amount of back taper desired. On small sizes, however, this is impractical, and on very small sizes absolutely impossible. Therefore, in order to obtain a die made in a way that will produce results required, the die must be tapped out from the back end with a tap having been cut with the taper required in the die.

The amount of the clearance mentioned should vary according to the kind of metal the die is to be used upon, the clearance being greater for brass than for steel. Opinions vary as to what is the best amount of back taper to give to a die. While some consider that a clearance of 0.003 inch per inch is ample for cutting steel or iron, and 0.005 inch per inch for brass, others claim that one might give even as much as 0.010 inch per inch clearance for steel and iron, and 0.015 inch per inch for dies cutting brass, copper and metals of similar structure. It may be safe to say that any figure between the extreme limits given above will prove satisfactory, and that the exact amount of clearance is comparatively unimportant.

A die made according to the latter method described would, when new, cut a perfectly correct thread. Suppose now that the die should wear, and in order to obtain the correct size of the thread the adjusting collar had to be tightened. In such a case a slight error in the form of the thread would occur, on the grounds mentioned previously, but considering the way in which this die is made, the error is reduced to a minimum. In fact, it is easily seen, that the maximum error, when a die of this kind is almost worn out, cannot be any greater than the minimum error occurring in a new die with the same length of thread cut straight, and made a sufficient amount oversize to produce the same amount of back taper by forcing the prongs in at the point.

The reason for continuing to manufacture spring screw dies in the old manner, when the superiority of dies made according to the system outlined is well known by manufacturers, is

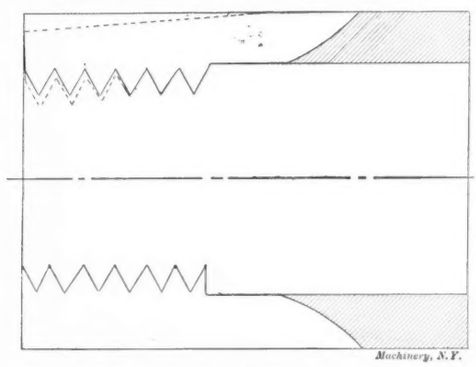


Fig. 1. The Faulty Action of Spring Dies of Usual Design when Adjusted for Smaller Diameters.

one merely of expense. It would make the die more expensive to grind on the outside, true with the thread, as a taper arbor would be more difficult to make than a straight arbor, but it is unquestionable that the increase in expense is very slight if compared with the superior qualities of the die. The grinding of the outside of the die should never be overlooked by those desiring a good die, especially if a solid holder is used. It must, however, be admitted that most dies made for the market are not ground on the outside, a fact of which most users probably are painfully aware, as it takes a great deal of experimenting and attention to produce desirable results with dies where the thread is not true with the outside. It also seems ridiculous to spend so much time and care in producing a good thread in the die, and then to overlook a factor equally important to accomplish perfect results.

Another point of utmost importance to make spring screw dies cut correctly is the way in which the prongs or lands of

ERIK W. OBERG was born in Vernamo, Sweden, 1881. He is a graduate of the Government's Technical College of Boras, Sweden. Upon concluding a term of apprenticeship with the Atlas Works, Stockholm, Sweden, he secured a position with the Bolinders' Mechanical Works of Stockholm. He then came to this country, where he has been employed by the Cincinnati Milling Machine Co., Cincinnati, Ohio, and Pratt & Whitney Co., Hartford, Conn. His positions have been those of draftsman and designer, his specialty being machine tools, automatic machinery, jigs and fixtures.

the die are being adjusted to cut the proper size. The clamp collars generally used for this are nothing but split steel rings. The adjustment is secured by means of a screw, and it is readily seen from the cut, Fig. 2, that the action of the steel collar on the prongs of the die is not uniform, that is, it will not give an equal pressure to the various prongs. The result of this will be a die with its thread out of round, and all the care and precautions taken in making a perfect die have become useless by the use of improper means for adjusting

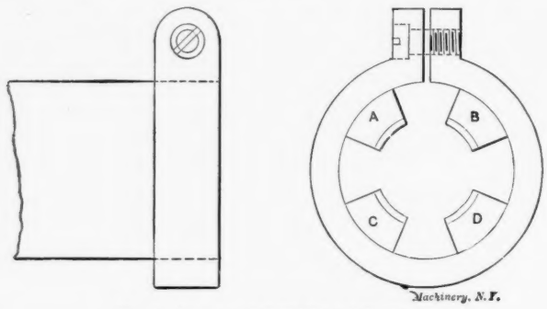


Fig. 2. The usual Split Ring Adjustment.

the prongs. Being out of true the die cannot have all the prongs cutting, which of course is essential in producing good results.

The only correct principle to apply for adjusting the prongs is a solid ring which will evenly force all the prongs equally toward the center. This can be accomplished by making a solid steel ring with the hole tapered, and tapering the fluted end of the die to suit the taper in the ring. (See Fig. 3.) The amount of taper in the ring and on the prongs will be directly dependent upon the adjustment wanted in the die.

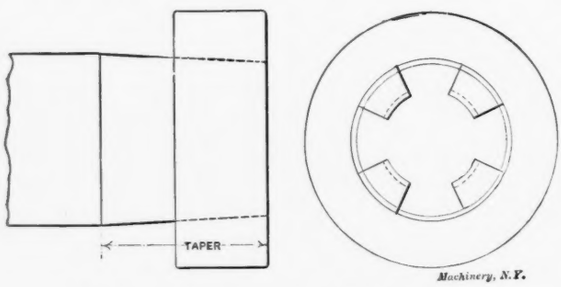


Fig. 3. The More Efficient Taper Collar Adjustment.

Spring screw dies are generally made with four flutes, but experience has taught that a die of this kind will almost invariably have only two lands cutting. A die with three flutes, however, will, even if slightly out of true on account of spring in the hardening, have the three lands cut evenly, and three flutes are therefore to be recommended. There is also another advantage gained by giving a die only three flutes. The lands become wide and stiff, while the chip-room may still be equally large or even larger. It may be said as an objection to wide lands that they will necessarily produce more friction between the die and the piece to be cut. This can easily be overcome by milling the prongs as shown in Fig. 4.

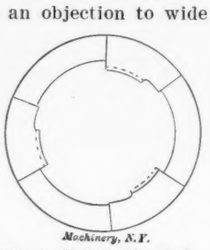


Fig. 4. Relief of Lands to Decrease Friction.

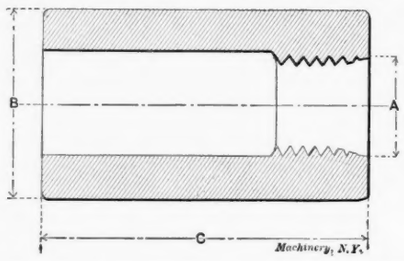
When fluting, the kind of material upon which the die is to be used, should also be considered. If the die is to be used on soft metals, such as brass, the cutting face of the prongs is usually made to come a small amount ahead of the center, while on dies used for steel or iron the cutting face is radial.

To prevent the die from springing out of shape in hardening it is advisable not to flute right through the metal into the hole, but to leave a small amount to be removed when grinding the flutes after the die has been hardened and finish ground on the outside.

The only point now remaining to be considered is that of the chamfer, which is, of course, greatly dependent upon the class of work to be done. It is evident that the longer chamfer, or taper on the top of the threads, one can allow in a die, the better results will be obtained, as it is obvious that a greater number of teeth will then do the cutting, and each tooth will have less to remove. The result will be a smoother thread.

Below will be found tables giving proper proportions of outside diameter and length of spring screw dies to cut certain sizes, and also proper length of thread necessary for certain pitches.

TABLE GIVING PROPORTIONS OF SPRING SCREW DIES.



Diameter of Cut.	Outside Diameter.	Length.	Diameter of Cut.	Outside Diameter.	Length.
A	B	C	A	B	C
$\frac{1}{8}$	$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$	$2\frac{1}{2}$
$\frac{3}{16}$	$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{3}{4}$	2	3
$\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{7}{8}$	2	3
$\frac{1}{4}$	$\frac{3}{4}$	$1\frac{3}{4}$	1	2	3
$\frac{5}{16}$	$\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{8}$	2	3
$\frac{3}{8}$	$\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{4}$	2	3
$\frac{3}{8}$	1	2	$1\frac{1}{8}$	$2\frac{1}{2}$	$3\frac{1}{2}$
$\frac{7}{16}$	1	2	$1\frac{1}{4}$	$2\frac{1}{2}$	$3\frac{1}{2}$
$\frac{1}{2}$	1	2	$1\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$
$\frac{1}{2}$	$1\frac{3}{8}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$3\frac{1}{4}$	4
$\frac{9}{16}$	$1\frac{3}{8}$	$2\frac{1}{2}$	2	$3\frac{1}{4}$	4
$\frac{5}{8}$	$1\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$3\frac{1}{4}$	4

TABLE GIVING THE LENGTH OF THREAD FOR VARIOUS PITCHES.

No. of Threads per inch.	Length of Thread.	No. of Threads per inch.	Length of Thread.	No. of Threads per inch.	Length of Thread.
40	$\frac{3}{16}$	16	$\frac{7}{16}$	8	$\frac{7}{8}$
36	$\frac{7}{32}$	14	$\frac{1}{2}$	7	1
32	$\frac{1}{4}$	13	$\frac{9}{16}$	6	$1\frac{3}{16}$
28	$\frac{9}{32}$	12	$\frac{5}{8}$	$5\frac{1}{2}$	$1\frac{5}{16}$
24	$\frac{5}{16}$	11	$\frac{11}{16}$	5	$1\frac{7}{16}$
20	$\frac{3}{8}$	10	$\frac{3}{4}$	$4\frac{1}{2}$	$1\frac{9}{16}$
18	$\frac{13}{32}$	9	$\frac{13}{16}$	..	...

* * *

The exigencies to which ocean freight is subjected require that goods for foreign shipment be packed much more substantially than for domestic shipment. This is obvious but unfortunately many American manufacturers appear not to understand it, or if they do understand it, they ignore it. The consequence is that American goods are commonly received by foreign consignees in very bad shape. The *Far Eastern Review* shows a number of halftones of shipments received at the Manila custom house in frightful disorder. One example is that of a hundred cases of watch chains whose contents are distributed about in a most promiscuous fashion. Examples of textile goods are shown in bad condition. In many cases the goods are so badly damaged that they cannot be sold at anywhere near full value. An example of a machine that was destroyed in shipment was a piano-player which had been well packed with the exception that the internal mechanism of the player itself was not well supported relative to its case. The consequence was that when it was inverted the supports were not strong enough to support the action and it was wrecked. So in packing machinery it should be remembered that first of all the case must be strong and well braced; second, that the machine should be securely blocked in the case so that it cannot shift relative to it, and third, that the parts of the machine itself shall be well supported by wooden blocks or other means so that if placed in a side or inverted position no destructive strain shall be brought upon parts unable to bear them.

FLOORPLATE WORK IN THE ALLIS-CHALMERS SHOPS.

The idea of carrying the tools to the work rather than of transporting the work to the tools is one of gradual growth in machine shop work, and we are unable to say when the first floorplate originated. But one thing is sure, and that is, the floorplate where special machine tools, driven by portable motors, are used to perform all the machining operations required on large castings, is one of comparatively recent development, being coincident with the growth of the electrical industry. In fact we may safely say the electrical industry is largely responsible; it made possible the concentration of power in larger units, undoubtedly, than would have been feasible by any means of lineshaft transmission, and the building of these large units made new machine shop methods imperative.

The Allis-Chalmers Co. at West Allis, Wis., in common with the other builders of large electrical and steam units has an extensive floor-plate system in their heavy machine shop No. 1. It has some features of novelty inasmuch as some of the tools are not strictly of a portable nature but are set with reference to the floorplate so as to allow of advantageous use

Fig. 1. General View of Heavy Machine Shop, at the West Allis Works.

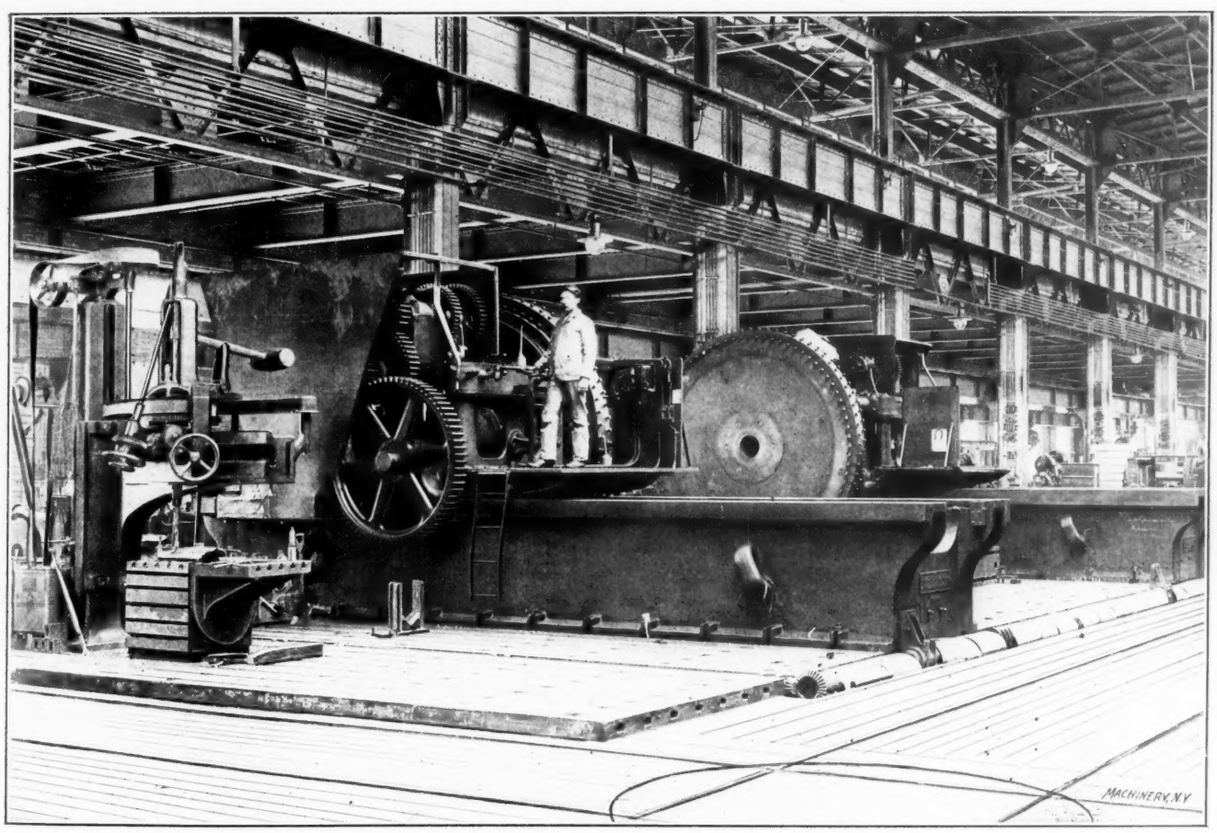


Fig. 2. Double Rotary Planer for Facing Housings and Cylinders.

with it and, in fact, so as to practically form a part of it. Fig. 1 shows a general view of this shop with the floorplate on the right. It is laid down in the central bay where it can be served by the large traveling crane, and it might be said here

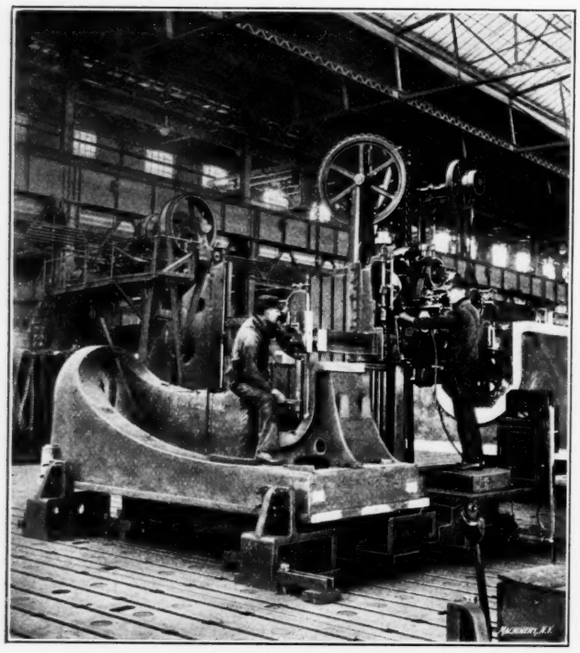


Fig. 3. Morton Shaper Finishing Main Bearing Seat.

that it is to the traveling crane that the floorplate largely owes its value.

The tool equipment of the floorplate of course required machines that can bore, drill, slot, face, mill and plane. Fig. 2 shows a pair of Bement-Niles rotary planers having cutter

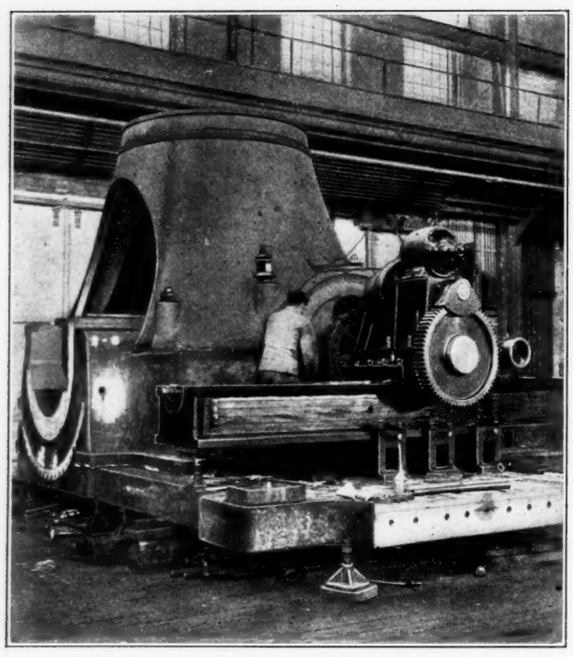


Fig. 4. Rotary Planer on Supplementary Bed Plate.

heads 120 inches diameter. These planers are set parallel so that they may operate on both ends of a casting at once, the heads traveling while the casting remains stationary on the floorplate. The distance between the two machines is adjustable, the large covered screw in the front showing one of the pair employed for shifting them. These planers are mostly used for facing housings and cylinders of large Corliss engines.

The planing operations are largely done on this floorplate with Morton draw-cut shapers. Fig. 3 shows one of these machines at work on the main bearing of a horizontal engine frame. The frame is fixed in blocks which support and clamp it in position and the machine is mounted alongside the floorplate, being driven, of course, by an electric motor as are all the others.

Fig. 5 shows another view of the Morton draw-cut shaper arranged for boring. This machine was designed for both planing and boring. In this case the boring head is mounted on the end of the planing ram, or rather on the end of the boring bar mounted in the ram. The head of the machine is counterbalanced by the pneumatic cylinder shown at the left of the column which avoids the heavy counterbalance otherwise necessary.

Fig. 4 shows a Newton machine tool of the rotary planer type; it happens to be used in this case on the housing of a vertical engine, using the bedplate as its support instead of

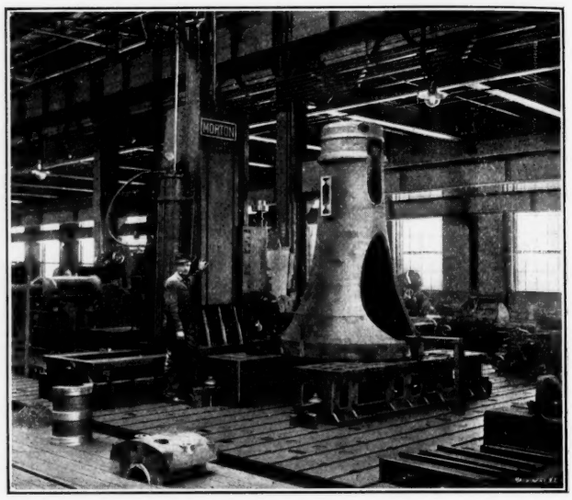


Fig. 5. Draw Cut Shaper arranged for Boring.

the regular floorplate. The motor is mounted on the traversing head, the same as with the machine shown in Fig. 2, the four-wire system connections showing on the side of the bed.

Fig. 6 shows perhaps the most interesting machine of the lot, being a special tool designed by the engineering department of the Allis-Chalmers Co. and built by the Niles-Bement-Pond Co. It is a boring and drilling machine, its work being the facing and boring of engine frames, and drilling the bolt holes for the cylinders, without the use of jigs. This machine is permanently erected upon a foundation adjoining the floorplate and is accurately lined up with the planed grooves

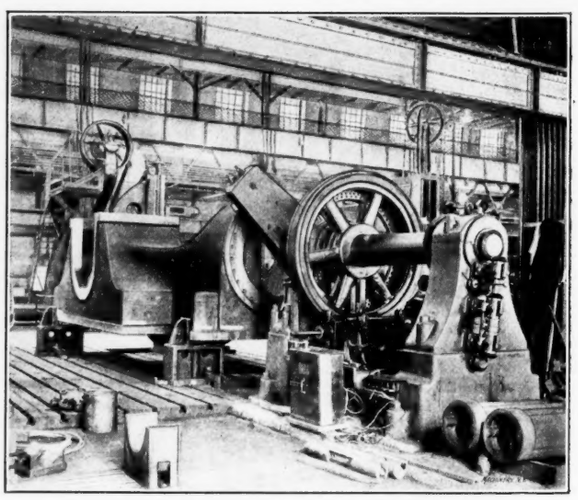


Fig. 6. Machine for Facing, Boring and Drilling Cylinder Ends, Etc.

in it. These grooves are also used, of course, for lining the engine bed which is to be machined. The indexing plate, with concentric circles of holes for indexing the drill arm when drilling bolt holes, is plainly shown in the cut. The tool carrier which is in position for facing the end has automatic feed for both transverse and longitudinal cuts.

THE APPRENTICESHIP QUESTION.

"ENTROPY."

Apprentices, their welfare, and the good of the shops hiring them, have held uppermost place in my thoughts for some time past. When I hear of anyone doing what Mr. Alexander is doing at Lynn I get to hoping that Prof. Sweet or some one like him will get a school going which shall be open to all comers. What Mr. Alexander is doing is a great step toward proving what I have always contended, namely, that apprentices, properly handled, are a paying proposition. But a little shop with 40 or 50 men and 5 or 6 apprentices of various stages of development simply cannot do what they are doing at Lynn. So far it seems to be impossible to find men with sufficient faith in apprentice education to back it either from a philanthropic or a business standpoint. But suppose we try co-operation. In my town there are quite a number of small shops that have about 30 apprentices among them. There is room for a lot more but this number they have. These boys are each learning to do some part of the work of the particular shop in which they are employed and do it in a way that their particular boss thinks is right. But the boy in the machine tool shop never sees a shrink fit made and the boy over where they are building rolling mill machinery never saw any scraping done, unless it were a babbitted box that didn't set down good. Most of these boys will be wise enough, if they are like their predecessors, to go away to some other shop when their time is out. They will be totally at sea at first both as to the work and the ways of the shop and the peculiarities of the new foreman. And they are not qualified as journeymen till they have beaten around a while. Now suppose these shops should swap apprentices occasionally so that in three years time they would have seen the inside of most of the shops and run up against several foremen, and they would be worth more to themselves and to their employers than they are now.

Then let the boys off a few hours a week, say the last two hours every day, and get some good shop man (no school teachers need apply) to give them lessons in arithmetic, natural science (physics they call it now but we used to take it sugar coated) just a little algebra and trigonometry, a whole lot of geometry and more drawing. A machinist can stand quite a lot of these things and not get so swelled a head but that he can keep his overalls on. If the man that teaches these things could go around from one shop to another all the week and see that the boys got a show at some decent work and that they knew the why of what they did, then they might be worth enough more so that the shops could afford to pay the teacher a fair salary. But then suppose these 30 boys had their pay cut down from an average of $300 per year, as it is now, to $200. They will stand it if they can see that they are getting something for their money. The best way would be to pay them just the same as now but to charge them a hundred dollars a year for the teaching done and for pushing them along faster. Take off the time limit and say to the boy, we will pay you what you earn regardless of whether it is 50 cents or $3 a day whenever you do earn it. Almost any boy with this incentive and the aid of the instructor can cut enough off his three years to more than pay this $100 per year. More than that even with only 30 apprentices less than $100 per year per boy will pay for the instructor, and one instructor ought to handle 60 boys easily, which would cut it still more.

But there is one thing still more vital to the interests of the machinery builder and that is the social position of his workmen. Just so long as a machinist is rightfully known as a "greasy mechanic" boys will prefer counter-jumping at $10 a week to running a lathe at $15. The ladies are at the bottom of it. Who wants to go to call on his best girl and find her sitting in the hammock with a bank clerk and know the reason is because the other fellow's hands are not grimy? I have known case after case where boys who have started into the machine business have left it to go at something clean because of wife or sweetheart. Now I have worked over the lathe and planer and gotten down into the dirt enough so that no one will accuse me of being a kid-glove mechanic if I have my say. I believe that a man can do a good day's work in a shop and keep clean. He cannot do it without more care on the part of the management than usually obtains and he won't do it unless he is compelled to by the management. Just why I don't know, but it is characteristic of a machinist that while in the shop he delights to wallow in dirt and when he is out he is equally delighted to kick about it. One thing that would help, unless I am greatly mistaken, would be to change his hours of travel so that he would not have to travel to and from work with the company of Poles and Dagoes that he rubs elbows with now. How can he hold up his head if he has to travel with that crowd? The next time when things are flush and you feel a desire coming over you to raise the pay of your help, cut off some time from the day's work instead of adding to their pay. Let them come down to work a little later than the Dagoes and go home a little earlier. Get them out in the collar and cuff and necktie brigade, and make them keep clean in the shop. They can if they will and you will, and it will pay you well and them too.

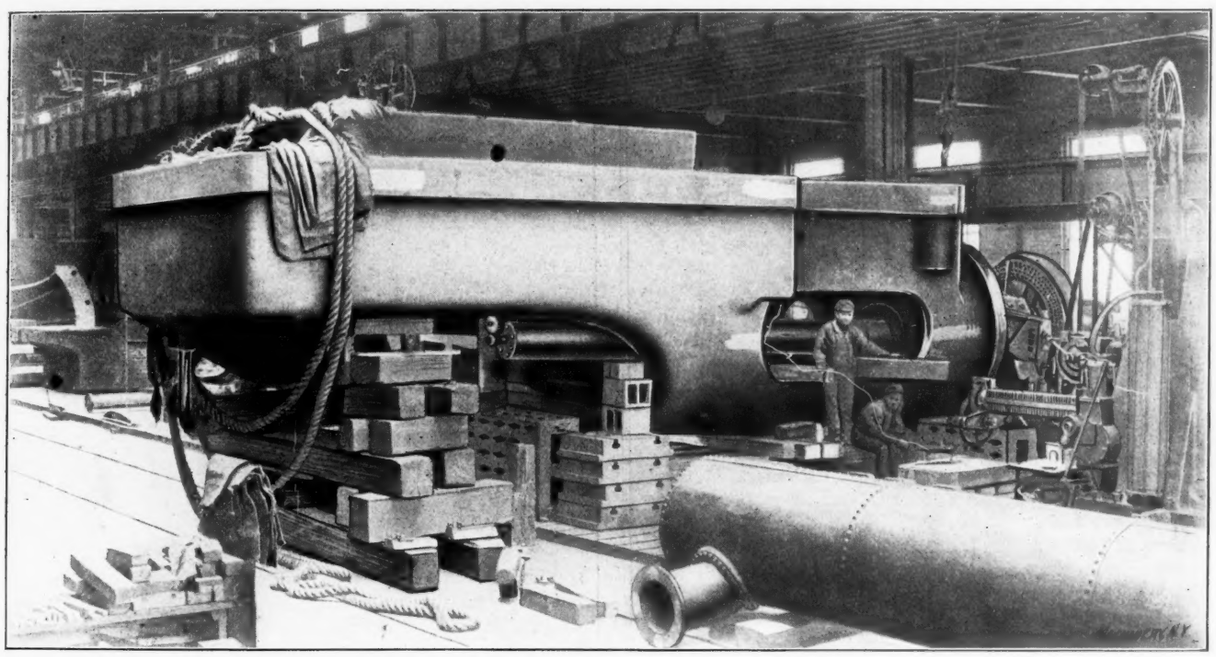


Fig 7. Facing, Boring and Drilling Machine, shown also in Fig. 6, Finishing the Cylinder End of a massive Rolling Mill Engine Frame. The Casting weighed 105 Tons.

PUNCH AND DIE WORK.—2.

E. R. MARKHAM.

Sectional Dies.

Dies are many times made in two or more sections in order to facilitate the operation of working the opening to shape. In other cases the die, if solid, would be so large as to render it well-nigh impossible to harden it in a shop with only the usual facilities for doing work of this class. And then again if it should go out of shape in hardening, it would be a difficult task to remedy the defect. If made in sections, as shown in Fig. 25, it would be possible to pene or grind to original shape with little trouble.

A die of the design shown in Fig. 26 may be made sectional because it is much easier and cheaper to make than if solid. The halves are held in their proper location by dowel pins. They are held together by the shoe which secures them in the press. If the die is comparatively small, the circular shapes at each end and center are produced by first drilling and then reaming from the back, with a reamer of the proper angle. The sections may be separated and the

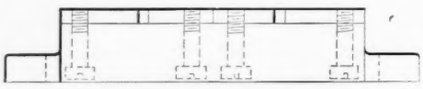


Fig. 25. Sectional Die held by Screws.

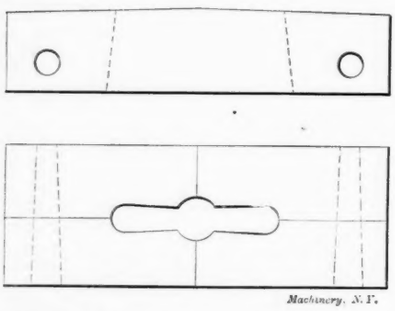


Fig. 26. Sectional Die Located by Taper Pins.

balance of the stock removed in shaper, planer or milling machine. When this stock is removed the die may be held at the proper angle to produce the desired clearance. After machining as close as possible the surfaces may be finished by means of the file and scraper.

When the opening has been finished to the templet, the top may be given the proper *shear*. In order to facilitate the operation of grinding when the die is dull, the stock may be removed, as in Fig. 27, leaving about ¼-inch each side of the opening at the narrowest portion. There are certain forms of dies where it is not feasible to cut away a portion of the top, as shown, but where it can be done it saves much time when grinding.

Should the workman, through misunderstanding or carelessness, make the opening too large at any point, he should not attempt to pene the stock in cold, as is sometimes done, for while it is possible to do this and then finish the surfaces

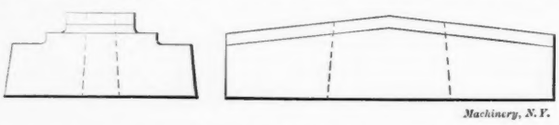


Fig. 27. Cutting away the Top to Facilitate Grinding.

in such a manner that it will be scarcely noticeable, the stock directly below where the pening took place will almost surely crack away during the life of the die.

Should the mistake referred to occur, heat the die to a forging heat when the stock may be set in without injury to the steel. When setting in, a blacksmith's fulling tool may be used, this placed on the face of the die and struck with a sledge, as in Fig. 28. If there is objection to disfiguring the top surface of the die, of course this method cannot be used, but if the top is to be cut away, as shown in Fig. 27, the depression made by the fulling tool would be entirely cut away. It is never good practice to bend, set in or otherwise alter the form of a steel when cold if it is to be hardened, as such attempts nearly always end in a manner entirely unsatisfactory.

When dies become worn so the opening is too large or the top edge of the walls of opening are worn so the die is "bell muzzled" it may be heated to a forging heat, set in with a fulling tool, or a punch of the desired shape, after which it may be reheated to a low red and annealed. After annealing it may be reworked to size. The writer has reworked dies

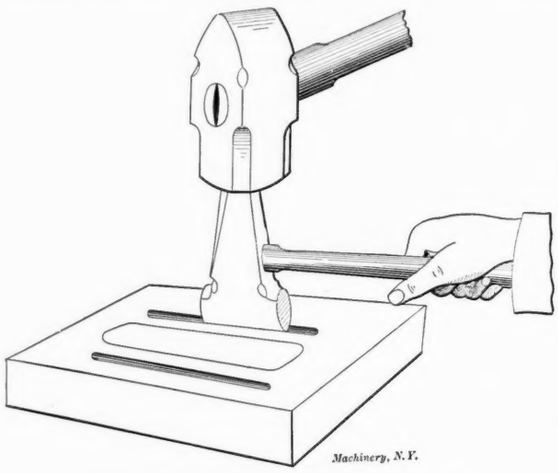


Fig. 28. Closing up a Die which has Worn Large.

several times in the manner described with excellent results, thus effecting a considerable saving, as otherwise it would have been necessary to make new dies, and the die could be reworked at a fraction of the expense of a new one.

When making a sectional die, it is possible in case the opening is a trifle too large, to work a little stock off the faces that come together, provided the outer edges have not been planed to fit the holder; also, if it is allowable, these surfaces may be cut away the desired amount and a strip of stock of the proper thickness placed between the die and holder. Considering the liability of a mistake taking place when the beginner is doing work of this kind, it is, generally speaking, advisable to leave the fitting of the die to the holder until the opening has been worked to size.

Hardening Dies.

There is probably no one article the hardener is called on to "tackle" that he dreads any more than a die. The more complex its nature the more he dreads it, and if he is at all nervous he will worry over it until he worries himself into a condition that makes it well nigh impossible to successfully do the job. If he succeeds in bringing it out of the bath without a crack, he gives the credit to "luck"; and if the expected happens it is no more than he was looking for. This is unfortunate, as there is no need of losing dies in the operation of hardening. Of course, if a piece of imperfect steel is used, it is almost sure to go to pieces in the bath; but if the steel is of the proper quality and in good condition, there need be no trouble when hardening. An experience of years in this business leads the writer to make this statement.

When handling work so diversified in character as the class under consideration, the operator should not assume that it is possible to adopt any set method which is not to be deviated from, as there is no one class of work that calls for a greater exercise of skill and common sense than properly hardening punch press dies, unless it be the hardening of drop-forging dies.

For most dies of this character, and especially those that are complicated in form, and which must retain as nearly as possible exact measurements, the writer knows of no method that will begin to give the satisfaction derived from the method known as "pack hardening," and which has been referred to so often in these articles.

When pack hardening such pieces, best results are derived from the use of a bath of raw linseed oil of the type shown in Fig. 29, in which the oil is kept from heating by pumping

through a coil of pipe in a tank of water, and then forced into the bath and through the opening as shown. If such a bath is not at hand, good results can be obtained where the oil is not agitated but the die is swung back and forth and moved up and down somewhat in the oil. If many dies are to be hardened this way, however, it is necessary to have a bath of generous proportions, or else several smaller baths, as it would not do to use the oil after it becomes hot, although oil that is heated somewhat will conduct the heat from steel more rapidly than would be supposed, and is better adapted for hardening than if it is extremely cold.

The secret of success in hardening dies by the ordinary method consists in getting as nearly as possible a *uniform* heat. To accomplish this the die cannot be heated very rapidly, as the edges and lighter portions would heat more rapidly than the balance of the piece. Unequal contraction, when quenching in the bath, follows uneven heating and unequal contraction causes the die to crack. High heats cause cracks in steel. Then again high heats render the steel weak, and as a consequence it cannot stand the strain incident to contraction of one portion of the steel when another portion is hard, and consequently rigid and unyielding. Steel is the strongest when hardened at the proper temperature, known as the refining heat.

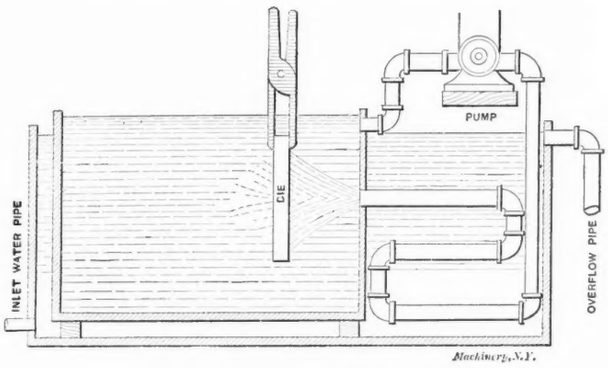


Fig. 29. Arrangement of Oil Cooling Bath.

Cold baths are a source of endless troubles when hardening dies. They will not make the steel any harder than one that is heated to a temperature of 60 or 70 degrees, or even warmer than this, but they will cause the die to spring or crack where the warmer bath would give excellent results. The writer prefers a bath of brine to one of water for this class of work, the brine being heated to the temperature mentioned above.

Have the bath of generous proportions. When the die is properly heated, lower into the bath as shown in Fig. 30, moving it slowly back and forth as shown by dotted lines, which causes the liquid to circulate through the openings, thus insuring the walls of the opening hardening in a satisfactory manner. Then again, moving back and forth brings both surfaces of the piece in contact with the liquid, causing them to harden uniformly, and preventing an undue amount of "humping," as would be the case if one side hardened more rapidly than the other. The workman must, of course, exercise common sense when doing this class of work. If he were to swing a die containing sharp corners, intricate shapes, and fine projections as rapidly in the bath as it would be safe to do were the opening round or of an oval shape, it might prove disastrous to the die, as such a shape would give off its heat very rapidly, and as a result the fine projections and sharp corners would harden much quicker than the balance of the die; and as they continued to contract the projections would fly off, or the steel would crack in the corners. To avoid this, have the bath quite warm, move the die slowly, and as soon as the portions desired hard are in the proper condition remove and plunge in a bath of warm oil, where it may remain until cooled to the temperature of the oil.

I think I am safe in saying that *most* of the trouble experienced when hardening dies is occasioned by one of two causes—possibly both. The first cause is uneven heating, the second, cold baths. I have seen hardeners plunge dies into water where it was necessary to break the ice before the die could be dipped, and then they would swear about the steel, saying: "You can't get such steel as we used to have." It is a fact, however, that at no time in the past could steel be procured that was so well adapted to the making of tools as at the present time.

The Punch.

The method of holding the punch depends on its shape and the style of die, as well as on the holders at hand in the shop. If it can be made as in Fig. 34, with a shank to fit a holder which enters an opening provided in the lower end of the ram, it will be comparatively simple to make. At other times it will be necessary to attach several punches to a holder, as in Fig. 31. When these punches can be attached to the holder by means of round shanks it will be found a satisfactory method. For many forms of punches, however, this would not answer, it being found necessary to attach them by screws, dowel pins being provided to keep them in position, as in Fig. 32 at *a*. Then, again, it is sometimes thought advisable to use a fixture for holding the punches having a dovetailed

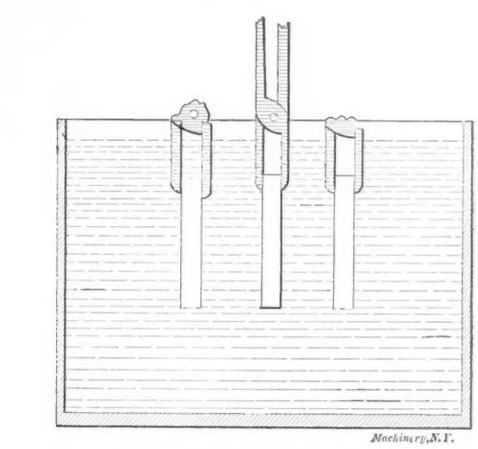
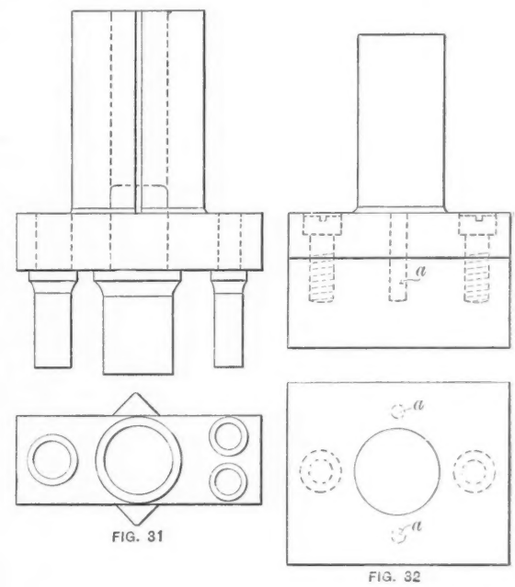
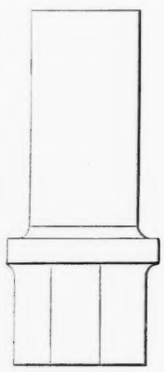


Fig. 30. Dipping the Work in the Bath.



Various Methods of Holding Punches.

slot cut in its face as in Fig. 33, the punches having a tongue which is fitted in the slot. The punches are securely held by means of setscrews. As the opening in the lower end of the ram to receive the punch holder of small presses is ordinarily square, the holder is made of a shape that fits the opening, the hole to receive the punch being round. At times the holder is split as in Fig. 35. When pressure is applied the holder is closed onto the shank of the punch, thus holding it securely. At other times the holder is made without splitting, and a setscrew placed in the lower end of the holder, Fig. 36. This setscrew, when screwed against the punch, holds it securely in place.



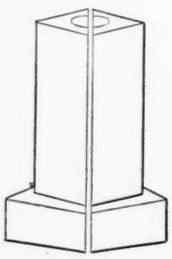


FIG. 35

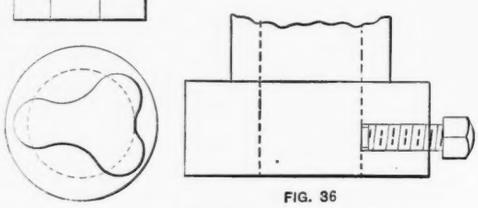


FIG. 36

Machinery, N.Y.

Fig. 34. Plain Round Shank Punch. Figs. 35 and 36. Shanks for Rams with Square Holes.

It is customary to make the die, and harden it, and then make the punch and fit it to the die. After squaring the end of the punch that is to enter the die, the surface is colored with the blue vitriol solution; or by heating until a distinct brown or blue color is visible, after which the desired shape is marked on the face by scribing. If it is considered advisable to lay out the shape by means of the templet, it may be done; but if the templet is not of the same shape on its two edges, or the ends are different from one another, it will be necessary to place the opposite side against the punch from that placed against the die when marking. However, it is the custom many times to mark the punch from the die. If the die is given shear, it is necessary to mark the punch before the face of the die is "sheared." When laying out several punches from a die which has a number of impressions, it is necessary to lay out the punch from the die.

The surplus stock on the punch is removed by filing, chipping, milling or planing, as the case may be, until it is but a trifle larger than the opening in the die. The end is then cornered somewhat so it enters the opening, and the punch is forced into the die a little way. It is then removed, the stock cut away, and the punch forced in again, this time somewhat further. This method is continued until the punch enters the die the required distance. It is then filed or scraped until the desired fit is obtained. When punch and die are to be used for punching paper, soft metals, or thin stock, the punch must fit nicely. If the stock is thick, or stiff, the punch may be somewhat looser. For stock ¼ inch thick it is the practice many times to have a 1-32-inch space between the punch and die at all points. The exact amount cannot be stated arbitrarily, it being governed by existing conditions.

There are instances in which it is advisable to make punches somewhat differently from the method described. When the nature of the stock to be punched is such as to cause it to cling to the punch, making the operation of stripping difficult, to the extent that any stripper plate put on the die would be bent, or the end of the punch pulled off during the operation, the punch may be made straight for a distance that allows of grinding several times, then the portion immediately above this may be given a taper. This tapered portion of the punch is intended to enter the stock, *but not the die.* Its action is to increase the size of the opening somewhat, thus making the operation of stripping possible without endangering either the stripper or the punch.

There are various opinions among practical men as to the advisability of hardening punches. For most jobs it is the custom to do so, though there are some mechanics who consider it advisable to harden them and others who do not. There are instances where punches work well either way, and in such cases it is, of course, a matter of opinion. If good results follow the use of a soft punch it may be used, and as the punch wears it is upset and sheared into the die.

There are times when a soft die and hardened punch work well, and times when a hardened die and soft punch give good results. At other times both punch and die may be left soft. I have used very large punches and dies for hot trimming drop forgings, where both were in a soft condition and they stood up nicely. The shape of these, together with the size, made it impracticable to harden them. Then I have used punches and dies both soft, for punching light materials, and found them to give good results.

I do not think it would be advisable to state that such and such dies or punches should be hard or soft; it must be determined by the circumstances under which they are to be used, and its decision is a matter of experience on that particular work.

If punches are to be hardened—and it is generally considered best—they should be very carefully heated. It must be borne in mind that punches are subjected to great strain, consequently they should be heated uniformly, and to as low a temperature as will give desired results, thus making them as strong as possible. Heat slowly to avoid *overheating* the corners, as these are subjected to the greatest strain. The distance we should harden a punch depends on the shape and size, and the use to which it is to be put. If it is a piercing punch of the form shown in Fig. 37, it should be hardened the entire length of the portion marked *a* to avoid any tendency to bend or upset when in use. If it is of a form that insures sufficient strength to resist any tendency to upset when in use, as in the punch illustrated in Fig. 38, then it need not be hardened its entire length.

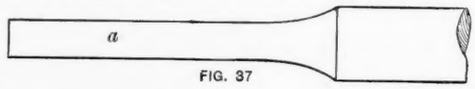


FIG. 37

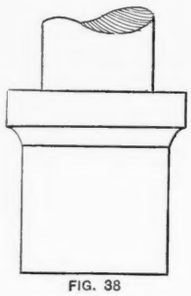


FIG. 38

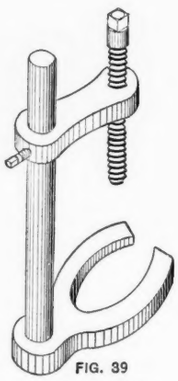


FIG. 39

Machinery, N.Y.

Figs. 37 and 38. Shapes Requiring Special Treatment in Hardening. Fig. 39. Clamp for Use in Scribing Die Outline on Punch.

Pack hardening makes an admirable method for hardening punches for most work, but for piercing punches of the type shown in Fig. 37 I do not advocate its use, as the whole structure of steel should be as nearly as possible alike. I would advocate heating in a muffle furnace, or in a tube in the open fire, turning occasionally to insure uniform results, for not only can we heat a piece more uniformly if it is turned several times while heating, but a fact not generally known is that a cylindrical piece of steel heated in an ordinary fire without turning while heating will many times show softness on the side that was uppermost in the fire, no matter what

care was taken when heating and dipping. If it is reheated with the opposite side uppermost, *that* will be found soft if tested after hardening, while the side that was soft before will be *hard*.

The smaller the punch the more attention should be given to the condition of the bath. I prefer luke warm brine. Work the punch up and down and around well in the bath to insure uniform results.

It is the custom of many mechanics to draw the temper of punches of the description shown in Fig. 37, to a full straw on the cutting end, but to have the temper lower further up the punch. Experience has taught me that better results follow if the punch is left of a uniform hardness its entire length of slender portion, as it is then of a uniform stiffness, and the liability of springing, especially when punching stiff or heavy stock, is reduced to the minimum.

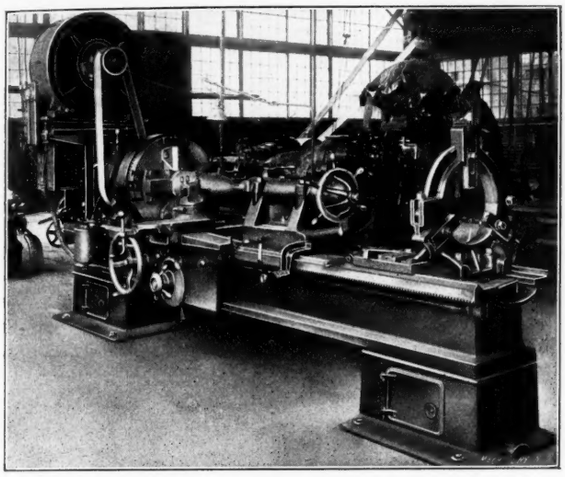


Fig. 1. Ten Horse-power Motor Operating a 26-inch Bullard Lathe; a 7-inch Projectile in Process of Turning.

It is generally considered good practice to temper the punch so it is somewhat softer than the die; then, if from any accident the two come in contact, the die will in all probability cut the punch without material injury to itself. There are exceptions to this, however. In many shops where large numbers of dies which are hardened are used, it is customary to have the one which is the more difficult to make the harder, so it will cut the other if they come in contact with each other.

In order to hold the die and punch blank firmly together when marking the shape on the face of the punch, a very convenient fixture known as a die clamp shown in Fig. 39 is used. When the two are secured by means of this clamp, it is possible to move them around so as to get at the various portions where we wish to scribe.

* * *

We hear much about the exploitation of the power of Niagara and of the enormous energy that has been running to "waste," as humanity regards it, for countless centuries. According to the utilitarian's view all that the Falls have been doing is to gouge out the canon, heat the water slightly, and for a comparatively few years furnish thrills and scenery for the tourist. Referring to the heating of the water it is worth noting how little it is heated by the successive conversions of the potential energy of the water at the brink of the cataract into kinetic energy in its fall of 165 feet and then into heat. The British thermal unit (B. T. U.) determined by Joule is the heat measure of mechanical work, 772 foot-pounds (778 foot-pounds according to Rowland) being required to raise the temperature of one pound of water one degree F. Hence, one pound of water falling 165 feet would be heated the fraction of a degree represented by 165 divided by 772, or only 0.213 degrees F. The heating is actually less than this, because of the radiation and vaporization, which latter absorbs a portion by conversion into latent heat.

* * *

About 40,000 tons of tin are consumed annually in the United States.

MOTOR DRIVE IN A PROJECTILE SHOP.

The application of motors to machine tool driving which has been made at the new projectile shop of the Firth-Sterling Steel Co., Demmler, Pa., affords a striking demonstration of what may be accomplished in increased output when such an equipment is applied in an intelligent manner. The motors are of the new type of direct-current motors manufactured by the Westinghouse Electric & Mfg. Co., known as type S A. These motors have a speed range of 4 to 1 on a single voltage, the control being obtained by introducing the resistance in series with shunt field coils. Both mechanically and electrically this type is identical in construction with the well-known S motors built by this company, with the exception of auxiliary poles and coils, a feature introduced to control the field form during the variation of field strength necessary to secure so wide a range of speed.

The auxiliary poles are bolted securely to the frame midway between adjacent main poles. The winding of the auxiliary poles is connected in series with the armature and produces a magnetizing effect which is proportional to the armature current. This introduces a factor which compensates for the distortion caused by armature reaction and field weakening. In ordinary motors the effect of armature reaction is to shift the path of the magnetic flux, weakening the leading pole tips and, consequently, shifting the neutral point, necessitating a backward lead of the brushes to obtain a field for sparkless commutation. By introducing the auxiliary poles a commutating field is maintained in a fixed position regardless of load or direction of rotation.

The motor equipment of the Firth-Sterling shop consists of eight 10-horsepower motors driving eight 26-inch Bullard lathes, two 15-horsepower motors each driving a Bullard horizontal boring machine, and one 7½-horsepower motor direct-connected to a Bullard turret lathe. The speed of the motors is varied by controllers with 21 notches, giving 21 motor speeds.

In addition to the foregoing type S A motors, a line shaft which drives a group of small machines receives its power from a type S constant speed motor.

The chief product of this plant, as its name implies, is projectiles, and the adaptability of variable speed motors to this class of work will be clearly apparent by following the successive steps in the manufacture of projectiles.

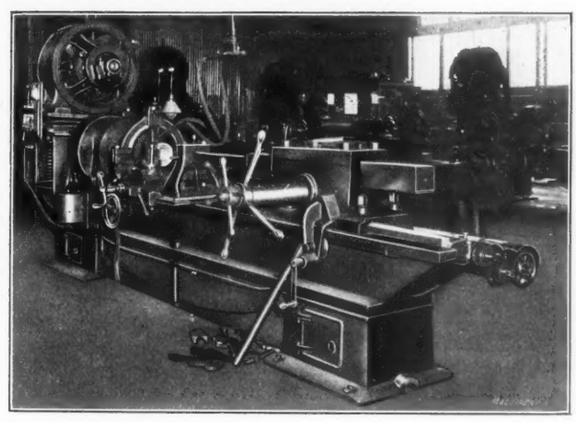


Fig. 2. Fifteen Horse-power Motor Driving a Bullard Horizontal Boring Machine; Projectile in Process of Boring Out.

The first step is the making of a steel casting similar in form to the finished projectile, but somewhat larger in diameter. After the metal has congealed it is removed from the mold and allowed to cool. The casting is then heated to a forging temperature and forged by a Bement-Miles steam hammer; when, after cooling, it is again brought to a red heat, placed in a receptacle, covered with lime and allowed to remain until entirely cool, the length of time depending upon the size of the forging. This is known as the annealing process.

After annealing, the forging is taken to the machine shop and the projection on the small end centered in a centering machine. It is then transferred to a lathe, the butt end being

chucked and the small end supported by the center in the tailstock. The machining is begun at the point of the projectile, the lathe speed being decreased with the increase of diameter by varying the motor speed, which illustrates one of the many phases of machine work where variable speed motors are exceedingly valuable, the operator being able to gauge the proper speed by watching the color of the chip.

After the lathe work is finished the partially completed projectile is placed in a cutting-off machine and the unfinished end that is clamped in the chuck removed. The work is then transferred to a horizontal boring machine where the recess or chamber for the explosive is bored out. The chamber is threaded near the butt to receive a plug, in the center of which is a smaller plug through which the fuse is inserted that is ignited by the firing charge and communicates with the explosive at a predetermined time interval, causing the projectile to burst after entering the object at which it was directed.

At two points on the barrel of the projectile the diameter corresponds to the bore of the gun and at a third point near the large end a groove is cut in the barrel into which a copper band is hammered, which, when finished, is slightly larger in diameter than the bore, causing it to engage in the rifling,

Fig. 3. View of a 7-inch Projectile Forging, Forging after Turning, and Completed Projectile.

giving the projectile a rotary motion. A groove at the butt provides a means for removing the projectile, if, for any reason, it is not discharged after being placed in the gun.

The point of the projectile is covered by a soft steel cap which, in some manner not thoroughly understood, enables the projectile to penetrate the plate with much lower velocities than are required with uncapped shells. The cap is held in place by wire driving into a recess formed by the coincidence of a groove cut in the interior with that of a groove cut out on the point of the projectile. The treating or hardening process to which the projectiles are subjected after machining is not made public.

An excellent opportunity for comparing the outputs of similar machines performing the same class of work is afforded at this plant, since in the old projectile shop of this company belt-driven lathes are still used, some with wide belts which have ample driving power. These belt-driven lathes are of the same type as the motor-driven lathes and some interesting tests of the number of projectiles finished in ten hours show the greatly increased efficiency of the motor-driven machines.

Diameter of projectile.....	6-inch	7-inch	8-inch
No. of projectiles finished in 10 hours, motor-driven lathe	38	32	25
No of projectiles finished in 10 hours, belt-driven lathe..	27	27	17
Per cent. increase.....	40.7	52.3	47
Average increase in output	46.6 per cent.		

The belt-driven lathes will eventually be equipped with motor drive, which is accomplished by adding an inexpensive mounting for the motor. The shop with the motor-driven machines presents a clean and light appearance; the absence of belting, with the exception of that driving the group of small machines, is a noticeable feature which naturally aids in cleanliness and gives unobstructed light, both natural and artificial.

A novel method of checking the efficiency of employees has been introduced by the Firth-Sterling Company, which is

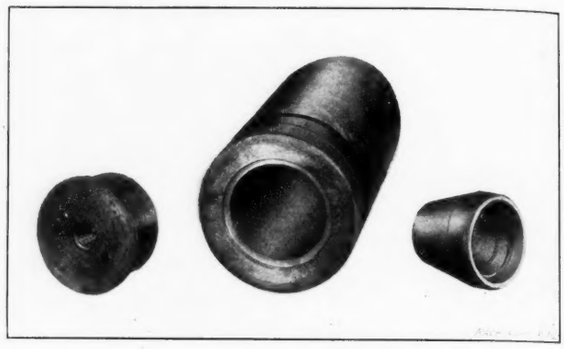


Fig. 4. View of Projectile, Plug, and Cap.

made possible by the use of electrically-driven machinery. It consists of placing in a convenient location for observation, a recording ammeter arranged to be connected in circuit with any machine whenever desired. Previous tests have determined approximately the current required for a given class of work so that the record of the ammeter indicates whether or not the machine is working up to its capacity and the time it stands idle.

* * *

One of the most complete heating and ventilating systems to be found in the country is that installed in the new U. S. Custom House now under construction in New York City. This is a large seven-story building occupying a lot 300 feet long by an average of 240 feet in width. With the exception of a small portion, an indirect heating system is used throughout. The corridors are heated by the special secondary utilization of the air after it has passed through the offices and rooms of the building, and will thus serve, with the elevator shafts, as vent outlets for all rooms heated. On account of the size of the building the heating and ventilating system was for convenience divided into four independent divisions,

Fig. 5. An 8-inch Completed Projectile and a Projectile of the Same Diameter after Penetrating an 8-inch Armor Plate.

each serving a section of the building adjacent to one corner. Each division has an independent blower and duct system, together with air washing apparatus, tempering and heating coils, and duct work. The blowers, of which there are four, furnished by the B. F. Sturtevant Co., of Boston, Mass., are three-fourths housing, peripheral discharge, steel plate fans with 12-foot wheels, 6 feet in width. Some novel and interesting features are introduced in the way of spray chambers, tempering coils and reheaters, dry chambers, and arrangements for avoiding back drafts to the rooms, etc.

SOME ANNEALING METHODS.

E. S. WHEELER.

There has been a great deal published from time to time in regard to the heat treatment of steel, but nothing about ways and means of annealing has come to the writer's notice in MACHINERY. I have endeavored to give below a clear description of modern methods of annealing work that passes through the toolmaker's hands. The systems in vogue to-day in our large factories give toolmakers little chance of knowing how this kind of work is done, and the majority of them have a poor conception of same.

Carbon or tool steel, as we all know, is hardened by being heated to a definite temperature and then suddenly cooled; annealing is just the reverse of this process so far as the

Fig. 1. A Simple Annealing Case.

cooling is concerned. The temperature of the piece (if it be a forging) should be very little above the forging heat and should be maintained no longer than is necessary to heat the mass of steel throughout uniformly. It should then be taken away from the fire and placed in a dry spot screened from

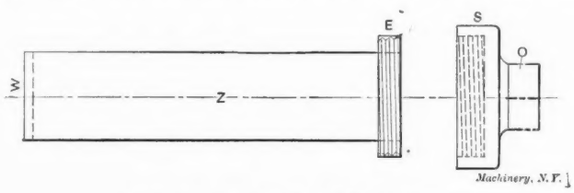


Fig. 2. Annealing Pipe with Welded Collar.

cold drafts. The slower the cooling the better will be the equalization of the stresses or strains in the steel. Annealing has the effect of throwing the carbon out of its normal combination with the iron, but all the annealing in the world will not make a steel right that has been misused previous to reaching the annealer's hands.

There is, in general, a confusion as regards burnt and overheated steel. A steel that has been heated to too high a heat is often wrongly called burnt steel without regard to the degree of overheating. Now, overheated, burnt and perished steel are all different, being the results of different causes and showing very different properties.

Steel is overheated when, without having undergone any detectable chemical change it has been made brittle and coarse grained by excessive temperature; not having reached, however, to the fusion point, the alteration of the grain being due to mechanical causes. Burned steel is steel which has been overheated until it emits sparks and thus has had the carbon burned out of it to a certain depth and become oxidized. The oxide near the surface fuses and destroys the coadhesion of the steel. Perished steel is steel which has become soft and lost its steely nature more or less by being heated too often in the open fire to the ordinary forging temperature; or it may be caused by having been kept soaking in the fire at the forging temperature too long.

It may be well to state here that no fixed temperature can be given for annealing all grades of steel. The refining heat varies with the carbon content. When annealing forgings or pieces that have been roughed out on the lathe or shaper and where a thin layer of decarbonized steel on the surface is not objectionable the pipe shown in Fig. 1 is used.

The bottoms *K*, *W* and *L* of the annealing pipes, Figs. 1, 2 and 3 are welded in. Fig. 4 shows a good way to put a bottom in the pipe. The pipe is bored at *O* so as to make a slight shoulder from 1/32 to 1/16 inch high. The pipe is then heated and expanded enough to receive the bottom *N*, which is placed in the recess and the still hot edges of *O* are turned in onto the beveled edge of *N*. In cooling the pipe shrinks tightly onto the bottom *N* and makes a very good substitute for a welded bottom.

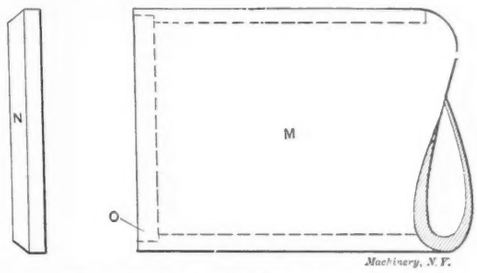


Fig. 4. Method of Attaching Bottom of Case.

In using the annealing pipe shown in Fig. 1, the bottom is filled with clean, fine charcoal to a depth of about 2 inches, and then the pipe is filled to within 3 inches of the top with the pieces to be annealed mixed with charcoal. The top is filled with charcoal the same as at the bottom, leaving a little space for a cap which is placed within the edge and luted with fire-clay. The hole *P* in the cap allows the gas formed by the charcoal to escape and prevents the cap from blowing out. Annealing by this method usually prevents the formation of a heavy scale because the charcoal takes up all the oxygen.

The pipe shown in Fig. 2 has a collar *E* welded on, which is threaded to receive the cap *S*. To charge the pipe first throw a cupful of rosin into the bottom and then put in the work and then another cupful of rosin on top, screw on the cap *S* by the square hub *O*. The cap should be threaded a loose fit so as to permit the escape of the gas. The pipe should now be placed in the fire and the rosin will be volatilized at once, filling the space around the work with hydrocarbon gases, which unite with the oxygen long before the steel is hot enough to

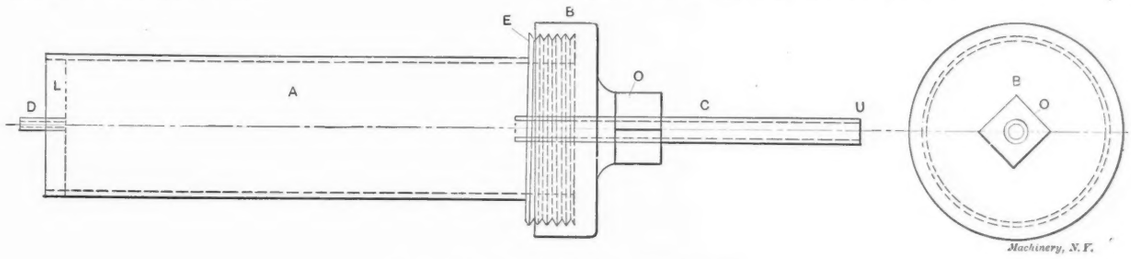


Fig. 3. Case for Use when Annealing in Gas.

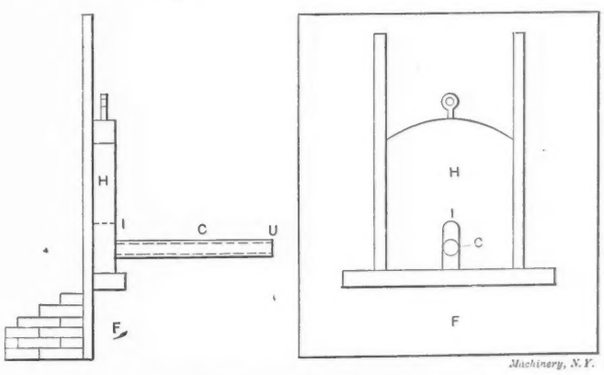


Fig. 5. Arrangement of Furnace Door and Gas Supply Pipe.

be affected. The formation of gas will cause pressure and it may be seen burning as it leaks through the threaded joint at

the cap. So long as the gas is escaping it prevents the air getting in and coming in contact with the steel, and so long as ogygen does not come in contact with the steel it cannot oxidize. This process leaves the work a dark gray color covered with a fine carbon soot.

The third method of annealing is done in an atmosphere of gas but by this method the presence of a decarbonized coating or coloring of any kind is absent and it is the perfection of annealing finished pieces. Steel comes out in just the same condition as it was before being put through the heat treatment. In Fig. 3 *A* is the pipe with the welded bottom *L* and the threaded band *E* for the cap *B*. *D* is a vent pipe screwed into the bottom *L* and there is a feed pipe screwed into the cap *B*. A thread is cut on the thread end at *U* for a pipe union. In Fig. 5 *F* is the front plate of the furnace door *H*, and it has a slot *I* through which the feed pipe *C* is extended out away from the fire. Now when the pipe *A* is charged it should be placed on an iron truck such as all modern hardening and annealing rooms have, which is about the same height from the floor as the furnace door. After filling *A* with the work to be annealed the cap *B* is screwed on and a hose is connected with the gas main and then coupled to the feed pipe *C* by the union at *U*. The gas is now turned on and as it escapes at the outlet pipe *D* it is ignited, this showing that all the air has been driven out of *A* and replaced by gas. The pipe *A* is then pushed into the furnace and the door *H* is let down, the slot *I* passing down by the feed pipe *C*. The gas continues to flow through the pipe during the annealing process and by keeping the pipe down to a proper annealing heat it is obvious that the steel cannot become any hotter than the pipe. There is not a great quantity of gas consumed in this operation because the expanding of the gas in the pipe makes a back pressure, the hole in the vent pipe *D* being quite small.

* * *

LEAD PENCIL MAKING.*

There is not a very remote antiquity to the lead pencil. Some old parchments are known that were marked with lead ruling, but this must have been metallic lead. LeMoine, a writer of the year 1537, speaks of documents marked with graphite. Other writers have found papers which were evidently written with a piece of graphite inserted in the end of a stick. This shows the evolution of the pencil, beginning with the use of graphite in connection with a stick.

The first pencil factory in America was founded by a school girl. There was a graphite mine in England at that time, called the Barrowdale mine. This school girl, from somewhere obtained some of these pieces, and anticipated quite closely the pencil method of modern days. In some way she crushed the graphite, either with a hammer or a stone, and then employed gum, mixing the two together, and then cut an alder twig, dug the pulp out, and stuffed the little alder cylinder full of this gum and graphite, and thus produced the first lead pencil made in America. This took place in Danvers, Massachusetts. Later a man by the name of Joseph W. Wade co-operated with this girl, and together they made a number of lead pencils after the same fashion. The girl's name is not known.

After Mr. Wade came one Monroe, who made pencils first at Concord, N. H. They were fairly well made and answered the purpose, and became articles of commerce at that time. About the same time the well-known literary man Henry D. Thoreau, also of Concord, made pencils. Thoreau was an impecunious man, always poor, always in trouble for lack of ready money, sometimes in debt, and at one time was put in jail for not paying his taxes. After he got his pencil business started, his friends said: "Now there will be an end to Henry's poverty," but he dropped the work about as soon as he commenced it, and said he could not afford to spend his time on something that was already finished. If he could have seen the lead pencils of to-day, he would not have thought that he had worked out to its full completion the evolution of the lead pencil. This happened somewhere about 1820 or 1825, in Concord, N. H.

* Abstract of speech made by Mr. John A. Walker before the "Boost" Club, New York, May 10, 1906.

After him came a man by the name of Wood. Wood associated himself with Monroe. Wood was a very clever fellow, an inventor and originator of clever machinery, and made some circular saws and knives which he set to work on pencil making. In that way he anticipated some of the up-to-date features of the present pencil machinery.

Joseph Dixon, the founder of the Joseph Dixon Crucible Co., about this time also made lead pencils after the same system. We have some in our office yet, that he made at that time. This practically completes the beginning of lead pencil making in the United States.

To go back to England, the Barrowdale Mine was the source of the graphite, and the pieces of graphite quarried were said to be in such form that they could be sawn and pressed into the wood. It could easily be foreseen, however, that pieces of this kind were not very numerous. It then occurred to a Frenchman by name of Conte to powder the graphite and put it together with a binding material, and he worked at it until he produced the graphite part of the pencil, substantially as it is made now. Not much, however, was done with it, either by Conte or by any other Frenchman. The Germans then took it up, and while this Frenchman was the originator of this system, to the Germans belong the credit of working it out and putting it into its present shape.

Concerning the coming of the Germans to America, Faber came first in 1861; the second American factory was founded by what is known as the American Lead Pencil Co. They started in 1864. In 1868 the Eagle Pencil Co. transferred their interests here, and in 1872 the Dixon Company started. The Dixon Company sold their first pencils in 1872.

The Dixon graphite mines are located at Ticonderoga, in the northern part of New York State, and the Dixon cedar mill is located in South Florida. They are so far apart that one day in the winter of 1904, when the mercury at the graphite mines was 40 degrees below zero, the temperature at the cedar mill was 70 degrees above. These graphite mines produce about 130 tons of rock and graphite every day, and the machinery for producing this is very large and consists of an elaborate system of crushing stamps and washing mills. The graphite is carefully separated from the rock before being sent to Jersey City. The first step in Jersey City is to get all the grit out of it. It goes through the process of washing and sifting, through many machines, until it is passed upon as absolutely perfect. The clay, which is the binding material, is treated in the same way. The clay is mined in Germany. It is cleaned and made ready for the mixture by an elaborate cleaning and sifting process. By a combination of the two, the so-called lead is produced, and by the blending of the two the grades are produced. The more graphite and the less clay, the softer the pencil; the more clay and the less graphite, the harder the pencil. In this way the various grades are produced, running all the way from very, very soft, until you reach the very, very hard. The soft leads are made larger than the hard ones, to obtain in that way the necessary tensile strength. When the mixture is perfected, it is put into a very heavy hydraulic machine, the bottom of which is full of holes. Heavy pressure is brought to bear and the mixture is forced through these holes and falls into a tub below. This is repeated time after time, until judgment assures the worker that it is well kneaded. Then it is put through a similar machine, with a single hole in the bottom. As it is passed through this single hole, it comes out as strong as a shoe string. The next step is laying these leads out on a board, 21 inches long, and when dry they are cut into lengths 7 inches long, placed in a crucible, sealed up, and baked in the kiln, where the temperature reaches 2,200 or 2,300 degrees F. After being taken from the kiln they are ready then to be placed in the wood.

The colored leads go through the same process, with the exception that a China clay is used for the binding material and the pigments are used instead of graphite, to give the different colors. It is the same way also with the so-called copying leads, where aniline is substituted for the graphite.

The consumption of cedar logs suitable for pencils is going on at a greater rate than the growth. One of these days, cedar will be a thing of the past. The pencil people will have to be

fore-handed in supplying themselves with a large quantity of cedar, to protect themselves against any contingency. The product of the sawmill is what is called a slat, which has the width of six pencils, the thickness of a half pencil, and is 7 inches long. In that condition they are sent to us in Jersey City by the carload. Where the wood will not produce six pencils, it is cut into five, or if necessary four, or three, or two. The expense of gathering the cedar and cutting these slats is immense. The next step is removing the pitch from the cedar. This is done by a system of boiling, and after the boiling they are thoroughly kiln-dried. Coming from the kiln, the slat is sent to what is called the grooving machine, where in one motion it receives the six grooves. From there it goes to the table, where the leads are laid in, after which the glued other half is fitted, and then they are confined in certain clamps, screwed up tight, and left over night. In due time the blocks are released, and are now ready to go to the shaping machines. These glued blocks, as they are called, are fed in at one end of the shaping machine, and the pencils, perfectly shaped, come out at the other end, and they can be either hexagonal, round, or any shape that one pleases. The knives cut them exceedingly smooth.

From the shaping machines they go to the varnish machines, to which they are fed with a hopper. Each pencil, as it passes through the varnish machine, gets itself coated with varnish, is picked up and returned, to get a second coat, etc., until it receives as many coats as the system calls for. It will be observed that the varnish in this way varnishes also the end of the pencil as well as the sides, so they then go to another machine that trims the ends. A preliminary trimming is done first, and then the partially trimmed ends are submitted to a very sharp knife, which finishes them.

One of the most troublesome rooms in the pencil factory is where the gold leaf is laid on. It has to be a room where the air is necessarily excluded. The gold leaf is laid on, and great skill and care is exercised in getting the gold leaf cut and laid on properly on a round or hexagonal pencil. The pencils are then conveyed to stamping machines, and the letters of the die are stamped into the gold. After the impression is made on the gold leaf, the surplus gold is rubbed off, and then we have the stamped letters as you see them on the ordinary pencil.

LUNCH ROOM AT THE ROCK ISLAND ARSENAL.

ALBERT D. KNAUEL.

That the Government is progressive is shown by the establishment of a noon hour lunch room at the Rock Island Arsenal, Illinois, for the accommodation of the employees.

This lunch room is conducted on the co-operative plan, the men having founded an association known as the Rock Island Arsenal Lunch Association. The officials are composed of men selected from the different departments to act as an executive board, with the approval of the commanding officer, Col. S. C. Blunt, Ordnance Department, U. S. Army.

A chef is employed to do the cooking, with eight assistants for waiters. The meal ticket, Fig. 4, is issued to each member semi-monthly, for which he pays ten cents a meal.

On the back of the ticket are printed the following rules:

This ticket is sold only to employees of R. I. Arsenal and is good only for the person to whom it is issued. Only in case of sickness or unavoidable absence from work of two or more days, or in cases of discharge or resignation, will the holder be entitled to rebate.

Members of the Association are expected to conduct themselves in an orderly manner while in dining room. Each member is requested to remove his hat at the table. Throw-

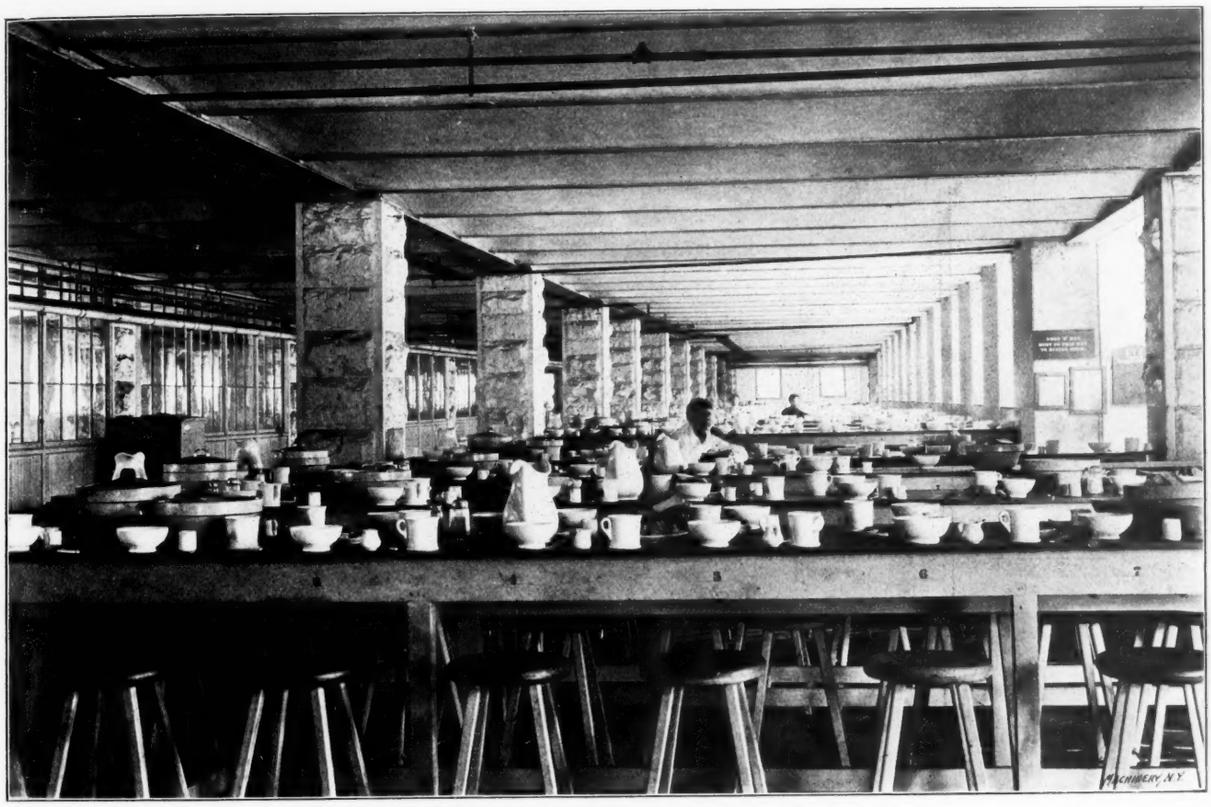


Fig. 1. East Wing of the Lunch Room at the Rock Island Arsenal.

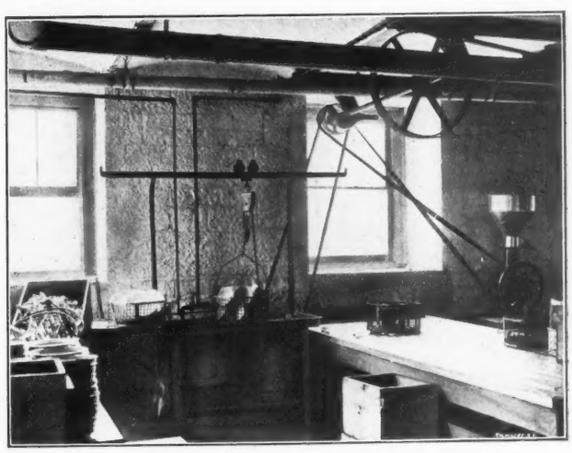


Fig. 2. Power-driven Dish Washer and Coffee Grinder.

ing food or coffee on the floor will not be allowed. Members are entitled to one cup of coffee or milk each day. All complaints should be made to the manager.

By order of the Dining Room Committee.

In the view, Fig. 3, is the kitchen, in which may be seen to the right, the steam coffee urns, and to the left, the soup boilers. This is a well appointed kitchen, all the utensils used being made at the arsenal. Fig. 2 shows the power dishwasher and coffee-grinder. Fig. 1 shows the line of tables, in the east wing, set for dinner.

The entire east wing and south bay of the basement of Shop B is used for the dining room. There are 75 tables seating 1,200 men but at present only 600 men are served. About 125 gallons of coffee, 120 gallons of soup and 250 loaves of bread are consumed daily.

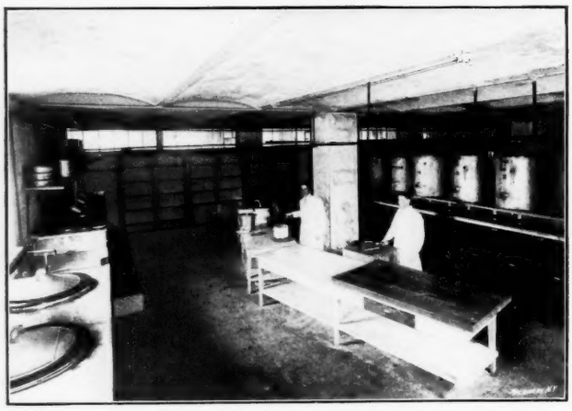


Fig. 3. View of the Kitchen.

The bill of fare for one week consisted of: Coffee or milk, bread and butter; sliced corn beef, vegetable soup with crackers, corned beef hash, Frankfurters with potatoes, rice soup with crackers, cold sliced beef with potatoes and other variations, all for ten cents a meal.

The association owes much of its success to Colonel Blunt whose efforts to bring this movement to a permanent standing were unceasing.

* * *

One of the curious discoveries made in connection with windmills is that a wheel composed of slats closely spaced will not develop as much power for the same area as one wherein the slats are openly spaced, that is, with considerable distance between them. This fact was discovered accidentally by Sorensen in making some windmill experiments when part of the vanes of the mill on which he was working were carried away. Much to his surprise he found that the wheel developed more power than before. Thereupon a wheel with only six vanes was built and this developed more power under the same conditions than could be obtained from the "ventocrat" or "rose of the winds" systems. The later development of the Sorensen wheel arranged the six vanes on the surface of a cone with the tips of the vanes flared slightly forward, the apex of the cone being presented toward the wind. In this connection it is asserted that a board fence in which the boards are closely set together will not blow down as quickly as one in which the boards have considerable space between them.

10	**R. I. A. Lunch Association**	9
11	*Limited Ticket—Not Transferable*	8
12	*For Employees—Rock Island Arsenal only*	7
13	Issued to Mr.....	6
14	From ..... To.....	5
15	No..... THIS TICKET GOOD FOR ONE MEAL ON DATES HEREON WHEN STAMPED BY MANAGER	4
16		3
17	18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 1	2

Fig. 4. The Meal Ticket.

GLUES AND CEMENTS.

We have seldom met with a more useful handbook than Mr. H. J. Cassall's shilling volume on "Glues and Cements," just published at the *Bazaar* office, Drury Lane, W. C., by Mr. L. Upcott Gill, says the *English Mechanic*, and the following quotations from the book are appended:

"Cements and adhesives are of many different classes. First, there are those which are always ready for use, and which need no preparation of any kind. Such are the 'liquid glues,' ordinary office gum, the pastes, etc. The second class takes in those kinds which are ready so far as mixing is concerned, but require some preparation such as heating before they are soft enough to use, and of this class the most representative variety is common glue. A third section comprises those which need some liquid added to the stock of compound to fit them for use, and a fourth includes those which require to be made up every time one of the class is needed. Of all these there are many varieties, applicable to different conditions and substances, and most of them are further divisible into adhesives and cements.

"Broadly speaking, the difference between an adhesive, or glue, and a cement is this: an adhesive is for use when the surfaces to be joined coincide more or less exactly, and consequently such surfaces hold together almost directly. A cement, however, is for use where there are irregularities in the surfaces which are to be joined, and these must be filled with the joining medium, which holds onto itself as much as to the surfaces being fixed. A cement, in fact, first makes a surface by filling up irregularities, and then acts as an adhesive.

"Thus, in joining porcelain which is newly broken but unchipped, and in which, therefore, the two surfaces, although irregular, coincide exactly, the best job will be made where there is as little glue as possible used, for the closer the broken edges are together the better they will hold. The cement or mortar which is used for a wall, however, has first to fill up all the irregularities and holes in the bricks, for such irregularities are not coincident, and the wall holds together not because one brick holds to the next, but because it has had attached to it a coinciding surface of cement in the first place, and the brick under it has received the same, so that it is the brick and its layer of cement which hold to the next layer of cement and its brick. It will be obvious, therefore, that such a cement when set should be as strong as the substance joined. Although this is not recognized in the practice at least of the present day, whatever it may be in theory, yet both practically and theoretically was it carried out by the builders of olden times. They made their mortar so much stronger than we do now that in many old buildings we can see that the bricks have decayed through the action of time and weather, leaving the still intact mortar standing out like a grid.

"But the scientific method of classifying adhesives and cements should be in accordance with their mechanical actions. Their setting depends upon various causes, and if these are not present they cannot set, but will remain liquid or soft for ever. This is an extremely important point, because although a particular adhesive or cement may be the very thing when applied to two substances under some conditions it would be quite useless under others, because the special conditions under which it hardens will not be present. For instance, ordinary glue will stick tightly on most metals if they are chemically clean. But its mechanical action—that is, the method by which it sets—depends mainly upon evaporation of the water contained in the glue. If, therefore, we attempted to glue together two pieces of metal with this adhesive, only the edges where the air could get at it would dry—the central part could never evaporate, for the metal is non-absorbent, and as the glue at the edges would become hard first the water could not get away between them.

"This is merely an example of our point that the methods of setting of various adhesives have to be taken into account when using them. As this book is not merely a string of recipes of glues and cements, we shall mention the various mechanical actions upon which such substances depend for their efficiency, for the reader, if he can master those princi-

ples, will be able to compound his own cements to suit anything or any combination, whereas it would be all but impossible to give every glue and every cement which can be made, and which can be applied to every condition. The most ordinary method by which an adhesive hardens is, of course, by evaporation. Of such adhesives glue is the commonest, and the sticking agents compounded of spirits and rosins act in the same way. A second method is by cooling. Typical examples of this are sealing wax, the marine glues, pitch, etc. Thirdly, there are those which depend upon absorption of something from the air. Common mortar is among these. Its action is purely chemical, and it depends upon absorbing from the atmosphere carbonic acid gas. Others depend upon taking oxygen from the air, and thus oxidizing themselves into a different substance which is hard and tenacious. White lead is such a cement, the linseed oil in this instance being the medium which changes by oxidation into a hard substance (very much akin to India rubber from a chemical point of view) that binds the particles of the white lead together. Then, again, there are cements which depend upon absorbing water from the atmosphere instead of giving it out by evaporation; others are mixed with water and combine with it, changing their structure in the process—*e.g.*, Parian cement and plaster of Paris; and there are yet others the ingredients of which combine together to form something different without any help from the air, or the water, or the carbonic acid gas therein contained. It is important to take the above points into account when joining things by adhesives, and it is for this reason that the subject has been somewhat enlarged upon."

* * *

THE GROWTH OF THE TRADE PAPER.

The newspaper has a long history and although its development within the last 30 or 40 years has put the older efforts so far into the shade as to make them appear very puny, the followers of the "news letter" are essentially the same in principle as their progenitors. It is true the telegraph has supplanted the stage coach and the perfecting press the hand press of Benjamin Franklin's time but the gathering of news and gossip of ephemeral character and its dissemination is still the function of a newspaper and will so continue to be. The oldest publication in The United States, originally a newspaper, is the *Saturday Evening Post*, founded in 1728 by Benjamin Franklin. Now it is a special publication filling a place between the newspaper and the magazine. It is rarely that a daily paper can present an article which reviews and summarizes a situation and points the trend of progress or draws a conclusion. A valuable feature of the publication referred to is that it presents articles which review conditions, marshals together related facts and gives the readers in a few words a grasp of a situation which they could scarcely ever get by reading newspapers. An article contained in the May 12-19 issues is on what the author is pleased to call a new profession, and that is editing and writing for trade papers. The trade paper, as we all know, is a comparatively new idea in journalism, strictly class papers being few that have an age greater than 25 or 30 years. But there are now hundreds of trade and class papers devoted to almost every trade and profession, some of which have a standing, capitalization and organization which rival that of small city newspapers. The writer of the article, Mr. James H. Collins, believes that the possibilities in trade journalism are considerable and that the business is one that affords many opportunities to the trained writer who also has technical knowledge. He says in part:

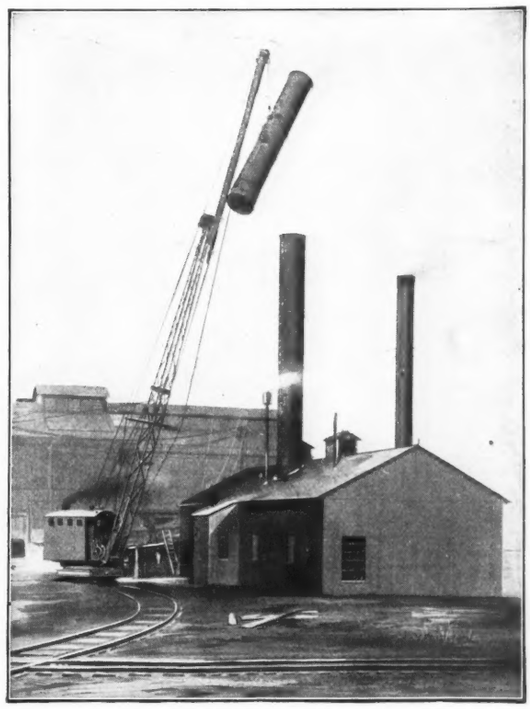
"But while the trade journal has been developed phenomenally on its business side, its editorial growth has been less rapid. The newspaper and the magazine have certain literary traditions and heritages that have come to them through a long period of development. The trade journal has none. Each publication of this class, coming into a technical field that had never enjoyed a medium for the spread of information, was forced to make its own methods. And in the development of its editorial policy literary skill was usually unavailable. Engineering journals grew out of the prolix official report. Publications launched to keep a retail trade informed on prices, new goods and shop methods, were written by merchants and clerks. Contributions to journals dealing with machinery came from mechanics and foremen. One by one new trade fields were furnished with their especial journals, written from their especial viewpoint, in their own technical patois. To the newspaper and magazine writer these were Greek. But because the trade journals were written with yardstick and calipers, and illustrated with the blueprint, they had vitality. The exact information of engineers' reports, in which everything is stated with three synonymous adjectives, gave a basis upon which to build more direct articles. Journalistic and literary standards seem fatal to a trade periodical at the outset, but after the special field and patois have been defined by technical men, the trained general writer is often able to grasp them, shape a wider policy, vary subjects that trend toward set channels, and employ literary artifice not only in presenting matter more attractively, but in getting fuller, fresher information. For the technical half knowledge of a trained writer is often precisely the element needed to reveal and exploit points, that in the technical man's judgment, seem commonplace.

"The number of trade journals in the United States is now estimated at between fifteen hundred and two thousand. About four hundred and fifty are published in New York City, which has fourteen daily newspapers devoted to finance and commerce; seventy weekly and monthly periodicals to finance, commerce, insurance and markets; seventy-five to iron, steel, manufacturing, mining, building, and wholesale trade; thirty-eight to railroads, electricity, engineering and machinery; sixty to law, medicine, pharmacy, architecture, science and education; fifty to literature, art, music, the drama, publishing and advertising; fifty to retail trade; forty-three to sports, fashions, agriculture, etc., and fifty of miscellaneous character."

* * *

ERECTING A HUNDRED-FOOT STACK WITH A LOCOMOTIVE CRANE.

The locomotive crane shown in the halftone is engaged in a somewhat unusual task, namely, that of placing in position the upper section of a steel stack which, when completed, was fully 100 feet in height. The section being handled weighed 4½ tons and was swung at a radius of 25 feet from the pivot



Erecting a Hundred-foot Stack.

of the crane. The boom was lengthened for this particular job by tying to it a 40-foot timber. Allowing 10 feet for lap this gave a total of 95 feet for the length of the boom. The crane shown is one made by the Browning Engineering Co., Cleveland, Ohio.

Copyright, 1906, by THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1906.

PAID CIRCULATION FOR JULY, 1906,—22,114 COPIES.

MACHINERY is published in four editions. The practical work of the shop, is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A correspondent somewhat unkindly defines "toolmaker" and "mechanical engineer" as a machinist and draftsman respectively who have become afflicted with "swelled heads." A strictly technical definition of a swelled head is not at hand, but taking it in the sense of having a large opinion of one's self, and not as a condition of mere bumptitiousness, it is not quite so bad as it seems. To illustrate: A mechanical engineer is, in general, simply a man of good judgment and some mechanical ability, mixed with training, a knowledge of general practice, and—not least—a good opinion of himself. In short, he has confidence in his own ability and that confidence entitles him to the confidence of others. No man can expect to have others believe in him unless he believes in himself. A good machinist who thinks that he is able to make tools generally ends by making them and then he is entitled to be called a toolmaker—so there you are.

* * *

ONE EFFECT OF INERTIA.

The tendency of water in motion to continue in motion in the direction in which it moves, or in other words, its tendency to move in a straight line, sometimes is the cause of disastrous results and sometimes may be taken advantage of by one who bears this principle in mind. An engineer recently expressed himself as averse to the use of separators for extracting water of condensation from steam supplied to a steam engine because at best they are bound to break up the water into particles to a greater or less extent which are likely to become entrained with the steam and enter the engine cylinder with it. He contended that it was never necessary to use a separator because the piping could always be put up in such a way that the steam would free itself of this entrained water. His plan was to continue the steam main a short distance beyond the point where the vertical pipe connecting with the engine led off from it; and then connect a short vertical pipe, closed at the bottom, to this extension of the main line, its purpose being to act as a pocket for any water that might collect. When a slug of water came over with the steam it would shoot by the vertical pipe leading to the engine and continue in a straight line to the reservoir at the end of the main pipe, where it would be collected. The steam would turn the corner and travel down to the engine, but the water would not and so would be effectually eliminated.

As a further illustration of this principle may be cited the case of a certain steam engine which had a way of knocking off its cylinder head, owing to water entering with the steam. The cylinder was provided with relief valves placed near the heads in the cylindrical shell of the cylinder, after the usual custom, but they were of no avail and repairs were necessary a number of different times. It was finally suggested that one of the relief valves be placed in the center of the head end of the cylinder, since it would be more apt to act effectually at this point than at the side of the cylinder. The experiment was successful. Whenever water accumulated the pressure was instantly relieved in the cylinder by the opening of the relief valve and no more trouble ensued. As the piston advanced the water lying on the bottom of the cylinder would be driven in an upward direction against the cylinder head and the relief valve at the center of the head was directly in the line of the moving water, while the valve in the usual place at the side of the cylinder is quite out of the path of the water. If the relief valves are to be located in the walls of the cylinder at all, they would very likely be more effective at or near the top of the cylinder than at the side.

* * *

THE ADVANTAGES OF GOING SLOW.

It is possible that some of our readers have been amateur farmers at some time or other. If this is the case, it is also possible that they have been, like most of the tribe, impressed with the comparatively large returns that were obtained from the flock of fifteen or twenty hens which kept the family supplied with eggs. Perhaps some of them, charmed with the prospect thus presented, went into the business quite heavily, only to find that the aforetime cheerful and productive hen, when exploited on a large scale, developed an alarming appetite for a bird of its size, and evinced therewith no great anxiety to give an adequate return for favors received. A little thought would have convinced the experimenter that the feed bill per hen per month is bound to be greater with the large flock than with the dozen fowls who lived mostly on kitchen scraps and the bugs from the neighbors' lawns.

But there are other industries besides hen farming in which men have discovered to their sorrow that wastes and leakages which are invisible when business is done in an experimental way, develop to such an extent as to make the venture unprofitable when carried out on a large scale. In a western city some little time ago the writer noticed a plant composed of concrete buildings put up in a solid and substantial manner, evidently not many years old, which yet gave evidence of not having been used for many months. On inquiry it was found that the plant had been erected by a local lumber manufacturer who conceived the idea of using the sawdust and waste developed by his factory in the production of wood alcohol. An expert chemist was hired, and in due time an experimental plant was built in which the waste was successfully utilized for the purposes desired. So far as the manufacturer was able to determine, the alcohol made in this experimental plant was produced at a very fair profit, and the prospect seemed so bright for making money from what had hitherto been a dead waste, that he at once proceeded, under the advice of the expert chemist, to build a plant of sufficient size to take care of the entire output of refuse from the mills.

This plant, however, did not work, and it stands to-day a monument to the failure of this man to carefully analyze the conditions under which his experimental apparatus was operated. Many expenses which before had seemed to be so slight as to be negligible, became important factors in the larger plant. The items of repairs for the apparatus, the cleaning of the various vessels, stills, etc., and the rapid deterioration of some portions of the equipment, were factors with which he had not reckoned. The chemist, either from design or from inability to appreciate these points, had not enlightened his employer on this subject, so the project ended in absolute failure. The ability to analyze conditions from experiments on a small scale is a comparatively rare gift but it is a very necessary qualification for one who plans to embark on an enterprise with whose details he is not very familiar.

SOME EVILS OF EXTREME SECRECY.

When the Pennsylvania Railroad Co. let the contract for building its tunnels under the Hudson and East rivers, one of the stipulated conditions imposed on the contractors was that they should give absolutely no information whatever to the public as regards the progress of the work, the methods of construction, the difficulties encountered, or anything in the way of gossip regarding the work. Why such a gag should have been imposed is not clear. Although the tunnel under the Hudson River was of a type never before constructed, we believe its design in all essential features was necessarily made public in the plans which had to be submitted to government, State and municipal authorities, and so far as we know nothing expected to be encountered in the construction work was of a nature that necessarily called for secrecy. Whatever may have been the expected benefit, we do know that the policy of secrecy has been detrimental to the standing of the company and contractors. In the absence of exact knowledge, the newspapers have published exaggerated reports, alleging that large numbers of the workmen died of the caisson disease known as the "bends," and asserting that the work had met with such enormous difficulties that it is very doubtful if it could be prosecuted under the East River so as to complete the four bores within the contract limit of two years. So insistent became the clamor that finally the officials of the company were induced to remove the gag of secrecy and allow Mr. E. W. Moir, of S. Pearson & Co., the English contractors, to give out a statement of the actual conditions. He expressed the situation very graphically, saying: "I am working with my hands tied behind my back. People can say whatever they want about us, and we cannot tell the truth. We do not like the gag that has been put upon us."

As a consequence of Mr. Moir's extended statement published in the daily press, and the fact that the tunnel work has since been inspected by engineers and others competent to judge of the conditions, it is now believed that the tunnel conditions are not nearly so bad as was the popular impression. The work is only about two months behind, and instead of there being something like one hundred deaths from bends there had been fourteen at the time of the statement. This number is fourteen too many, of course, but it is not due, according to Mr. Moir's statement, to lack of precautions on their part, but is owing in some degree to the men going out through the mud locks to save delay instead of through the regular exit, in which the pressure is gradually reduced, and to the presence of injurious gases in the tunnel coming from the East River mud. This latter seems a somewhat doubtful statement, but even so, the point to be made is that the public attitude toward the tunnel work will be quite different if a reasonable amount of information is given as to the progress, and the nature of difficulties undergone, and if it is known that all precautions possible are taken to prevent disease and accident. No one likes to think that any corporation or contractor is prosecuting a work in which men are needlessly killed, and in work like this of an extremely hazardous nature it is a very poor policy to follow any other but one of frank expression of the actual facts.

* * *

THE ARMOR PLATE SITUATION.

Up to two or three years ago the so-called armor-plate trust, consisting of the Carnegie and Bethlehem Steel Companies, supplied the armor plate for the United States battleships with practically no competition. The Midvale Steel Co. then erected an armor-plate plant at Nicetown, Pa., and entered the field as a competitor. The recent opening of bids for armor to be furnished for the new battleships *Michigan* and *South Carolina* demonstrated that the power of the trust has been broken, as for the first time in years the bids of the Carnegie and Bethlehem Steel Companies were different. The bid of the Midvale Co. was the lowest, the price being $345 per ton, with the exception of the bolts and nuts. The Carnegie bid was $370 per ton and that of the Bethlehem Co. $381 per ton, the former of which represents a drop of $92 per ton since the competition entered the field. The representatives of the latter company, finding they were underbid, made such strong protestations to Secretary Bonaparte that the contract for over 7,300 tons was finally divided, half going to the Midvale Steel Co. and one-fourth to each of the others. It was considered that in the event of the armor trust not getting any portion of the contract their plants would have to shut down, thus throwing their skilled workmen out and disrupting the organizations. The strategic importance of keeping all our armor plates in working shape was recognized, and much as the officials of the Navy Department might have wished to punish the erstwhile haughty trust it was not thought best to give the whole contract to the Midvale Steel Co. Moreover, there was some doubt as to its capacity being sufficient to fill the order as rapidly as it might be required. The situation at the present time is gratifying, but there is a suspicion that the present competition will not long exist, for probably strenuous efforts will be made to effect a combination and thus restore the monopoly.

* * *

Periodically the trouble comes up of contributions being sent to more than one publication, in syndicate style, and evidently in imitation of the practice of certain newspaper correspondents. While such practice may be allowable in newspapers which have a circulation restricted to a certain section it is by no means so with magazines and journals like ours, which have a world-wide subscription list. It seems very strange that some of our well-meaning contributors do not recognize property rights in contributions the same as they would in any other article for sale. When a contribution is sent to MACHINERY for pay it is expected to be exclusive, the same as if title were being given to any other piece of property, and the contributor has no more right to sell it twice over than he would to give the title twice to a piece of land. This principle is recognized in law as including manuscripts and a statute is in force intended to protect publishers from such imposition; but we always assume that it is done in ignorance. It, nevertheless, is very exasperating to prepare an article, make the cuts, and get it ready for publication, and find that the same article has appeared in another journal. It means that we lose the cost of the cuts and composition, and the time required for the preparation. Sometimes, as it has happened in the past, the article appears simultaneously and then there is nothing to do but refuse payment, a proceeding which we do not relish, but which seems about the only thing to do.

* * *

There has been some confusion as to the correct term to apply to alcohol which has been rendered unfit for drinking purposes without destroying its value for other uses. The report of hearings before the Congressional Committee of Ways and Means designated alcohol so treated as "denaturized," which form we have used, but the Standard dictionary in the latest edition gives preference to the form "denatured," with "denaturized" as the variant. The preferred form has the merit of simpler spelling and easier pronunciation; it is regrettable that the more cumbersome word has gained currency, for changing to the other may be slow, especially as it has received official recognition in government transactions.

* * *

An error occurred in the first paragraph of the article "Free Alcohol and its Effect on Industrial Conditions" in the July issue; it stated that the calorific value of ethyl or pure alcohol is about 28,500 B. T. U. per pound. The authority for this statement was found in "The Gas Engine," by F. R. Hutton, but this figure is over two times too large, probably being the calorific value for 1 kilogramme, inasmuch as the value of pure ethyl alcohol is from 11,000 to 13,000 B. T. U. per pound. Consequently the figures following the statement in this paragraph are also erroneous.

* * *

The formula for horsepower transmitted by belting in the article by F. Wackermann, July Engineering Edition, had for a denominator 500, whereas it should have been 550, thus making the formula as follows:

$$HP = \frac{(T - 0.012\,tV^2)\,V}{550}$$

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The Pacific Coast Railway Club, Oakland, Cal., have made announcement that, since the destruction of San Francisco by the great earthquake, April 18, it has held no meeting on account of the unsettled condition of affairs, and it has been decided that all club business will be suspended for the present.

The immense trade of Hamburg, Germany, is indicated by the fact that the sea-borne merchandise exported and imported during 1905 amounted in all to 17,374,218 tons, with a value of $1,268,161,000. As compared with the preceding year, this shows an increase of 1,500,000 tons in volume and of $123,900,000 in value. The main increase was in the imports, but exports also exhibited a substantial advance.

This is the way MACHINERY'S shop receipt No. 171 appears after being revised and put through Andrew Carnegie's spelling reform by the *Engineer:* "For cementing leather belts, 1 pound of good fish glue should be soaked over night in a pint of cold water and then heated and stirred until the glue is entirely dissolved. Add 1 ounce of dry white lead and after mixing thoroly, when nearly cool, add 1 ounce of grain alcohol. The cement should be heated when wanted for use. This cement is to be brusht onto freshly cut surface and clampt together by the use of boards on each side and allowed to dry for an hour or two."

A brief report of the progress of the "Technolexicon of the Society of German Engineers" has been received from the editor-in-chief, Dr. Hubert Jansen, Dorotheenstrasse 49, Berlin (N. W. 7). This ambitious work, which has previously been noted in MACHINERY, was commenced in 1901, the object being to compile a universal technical dictionary for translation purposes in the three languages, English, German, and French. In June, 1906, over 3,000,000 word cards had been collected, these being the work of 2,000 firms and individual collaborators at home and abroad who are assisting in the compilation. The work has so far advanced that printing will be begun by the publisher, J. J. Weber, Illustrierte Zeitung, Leipsig, Germany, some time in 1907.

The great floating drydock, the *Dewey*, which was built in the United States, for the naval station at Manila reached its destination in the early part of July after a trip covering 12,000 miles and requiring a period of nearly six and one-half months. It was considered by some to be a hazardous undertaking to attempt the conveyance of the drydock half way around the earth by towing. The successful outcome is undoubtedly due to the use of the steam towing gear, a device which has come into general use on ocean-going tugs during the past few years. This gear minimizes the stress on the tow-line by paying out and hauling in the cable so as to keep a nearly constant pull at all times, irrespective of the pitching of the two vessels. The *Dewey* went by way of the Suez Canal, leaving Solomon's Island, in the Chesapeake Bay, December 23. Notwithstanding the use of the steam towing gear, heavy storms parted the cable twice, but in each case the structure was recovered without sustaining damage.

The Supreme Court of Vermont has established a principle of vital importance to labor unions in that State, and that is the individual responsibility of the members of a union for losses caused to a concern by a strike. As the result of a strike in Rutland, Vt., a manufacturing concern in that city lost $2,500. The company brought suit against the union for compensation and got a judgment for the full amount. The case was appealed to the supreme court, which upheld the judgment, but the company was unable to collect the money as the union's treasury had no funds. Thereupon suit was brought against the individual members of the union under a provision of the State law which provides that judgment may be collected from the individual members of any association when it is composed of five or more members. This case was won by the company and upon being appealed the supreme court again sustained the judgment. Hence, the individual members of the union will be required to compensate the company for the amount of the damages as individuals.

Rails 331 feet long were exhibited at the International Exhibition held at Liege, Belgium, in 1905. These included an 85-pound grooved girder rail for street railway track, 331.28 feet long, and a 70-pound tee rail of the same length; also a light tee rail 252.56 feet long, of only 7 pounds per yard, for portable railway track. The two large rails were each made from a 5½-ton ingot, heated 1½ hour in the soaking pit to insure a uniform temperature throughout the mass. This was rolled in a rolling mill having blooming and finishing mills driven by an engine of 10,000 H. P.; the rail was rolled in five minutes, and was exactly 354.24 feet long, the ends being cropped to make a first-class rail of 331.28 feet. Owing to the restricted space, the rail, as it passed through the rolls, traveled up a steep inclined plane and over the top of a two-story building. When the rolling was finished, and while the rail was still at a bright red heat, it was attached to a locomotive which hauled it along the ground about 650 feet to a place where it could be left to cool slowly. These rails, as well as two tires 16.4 feet diameter, were exhibited by the Ougree-Marihaye Co. of Belgium.—*Engineering News.*

TEMPERING BY MEANS OF METALLIC BATHS.

The following list of alloys, numbered to correspond with the list of tempering heats, is given in the *Practical Engineer*. The colors corresponding to tempering heats are as follows.

	Degrees F.		Degrees F.
1. Light straw	430	6. Light purple	520
2. Straw	450	7. Dark purple	530
3. Dark straw	470	8. Bright blue	550
4. Light brown	490	9. Blue	560
5. Dark brown	510	10. Dark blue	600

Corresponding to these temperatures are the following alloys, which melt at the temperatures shown below, but in getting them fluid a few more degrees of heat are usually required:

	1	2	3	4	5	6	7	8	9	10
Lead (parts)	15	17	10	14	5	25	30	12	25	95
Tin (parts)	8	8	4	4	1	4	4	1	1	1

These alloys should be carefully made and then run into small strips of about ½ inch square, being afterward remelted. The pan should be carefully heated by gas if possible, and the metal should only be heated to such a point that the insertion of the tool causes it to set round the steel. When such is the case the steel becomes equally heated as the metal melts, and it can be allowed to remain some time in the metal before taking out and quenching. Another plan is to lay the tools on the cold alloy and allow them to remain until it melts, this permitting the steel to gradually warm through, and possibly giving better results in the hands of some men. Usually, however, the plunging of the tools into the molten metal is the method adopted, and provided time is given to allow of the absorption of heat to a sufficient depth, this gives good, tough tempering with the requisite hardness.

PERMISSIBLE LOADING FOR KNIFE-EDGES.

Loads of 10,000 pounds per inch of length on knife-edges for scales and testing machines, are permissible, says Mr. Joseph W. Bramwell in the *Engineering News*, but the pivot must be flat at its upper portion, normal to the load, and supported its whole length, with a minimum deflection of parts to insure reasonable accuracy. The quality of steel used in pivots and seats has an important bearing upon the allowable load. In all cases it is essential that a high-grade, uniform tool steel be used, having a carbon content of 0.90 per cent to 1.00 per cent. Such steel will take a very high temper and

yet have sufficient ductility to resist sharp blows without crumbling. The temper of the seats should be drawn to a very light straw color; that of the pivots should be slightly darker. For accurate results it is very desirable to know the heat which must be used to produce the proper hardness. The angle of 90 degrees for the knife-edge has given good results for heavy loads. For ordinary weighing machinery and most testing machinery 5,000 pounds per inch of length will be found an ample allowance. In a recent testing machine of 800,000 pounds capacity, made from the writer's designs, the two large levers had a load of 10,000 pounds per inch on the pivots for the maximum load. Each pivot had an effective length of 40 inches. The edge may be made perfectly sharp, for loads up to 1,000 pounds per inch of length. For greater loads the sharp edge is rubbed with an oilstone, so that a smoothness is just visible. A pronounced radius of knife edge will decrease the sensibility of the apparatus. The seat, if an angular one, is shaped with a small radius at the intersection of the sides of the angle.

Fig 1.

Fig 2.

Fig 3.

Fig. 4

Fig. 5

Fig. 6.

The Genesis of the Binder Knot.

THE EVOLUTION OF THE CORD-KNOTTER OF THE SELF-BINDING HARVESTER.

Extract from Paper: "The Art of Inventing," Mr. Edwin J. Prindle. Read at the A. I. E. E. Convention, Milwaukee, May 28-31, 1906.

A most interesting example of the evolution of an invention is that of the cord-knotter of the self-binding harvester. The problem here was to devise a mechanism which would take the place of the human hands in tying a knot in a cord whose ends had been brought together around a bundle of grain mechanically. The first step was to select the knot which could be tied by the simplest motions. The knot which the inventor selected is that shown in Fig. 7, and is a form of bow-knot. The problem was to find how this knot could be tied with the smallest number of fingers, making the smallest number of simple movements. As anyone would ordinarily tie even this simple knot, the movements would be so numerous and complex as to seem impossible of performance by mechanism. The inventor, by study of his problem, found that this knot could be tied by the use of only two fingers of one hand, and by very simple movements.

The knot will best be understood by following the motions of these fingers in tying the knot. Using the first and second fingers of the right hand, they are first swept outward and backward in a circular path against the two strands of the cord to be tied, as shown in Fig. 1. The fingers continue in their circular motion backward, so that the strands of the cord are wrapped around these fingers, as shown in Fig. 2. Continuing their circular motion, the fingers approach the strands of the cord between the twisted portion and a part of the machine which holds the ends of the cord, and the fingers spread apart as shown in Fig. 3, so that they can pass over and grasp the strands thus approached, as shown in Fig. 4. The fingers then draw back through the loop which has been formed about them, the fingers holding the grasped portion of the strands, as shown in Fig. 5. The knot is finished by the completion of the retracting movement of the fingers through the loop, thus forming the bow of the knot as shown in Fig. 6.

Fig. 7. The Knot Completed.

The inventor found that one finger could have a purely rotary movement, as if it were fixed on the arm and unable to move independently of the arm, and the movement being as if the arm rotated like a shaft, but the second finger must be further capable of moving toward and from the first finger to perform the opening movement of Fig. 3, and the closing

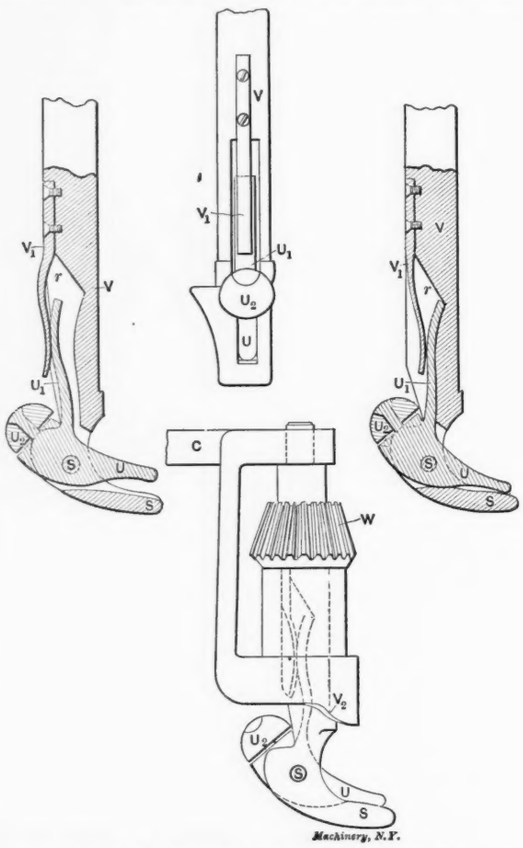


Fig. 8. The Essential Parts of the Cord Knotter.

movement of Fig. 4 by which it grasps the cord. The inventor accordingly, from his exhaustive analysis of his problem, and his invention or discovery of the proper finger motions, had further only to devise the very simple mechanical device illustrated in Fig. 8 to replace his fingers.

The index finger of the hand is represented by the finger *S*, which is integral with the shaft *V*. The second finger of the hand is represented by the finger *U*, which is pivoted to the first finger by the pin *S*. The grasping movement of the finger *U* is accomplished by a spring V_1 bearing on the shank U_1, and its opening movement is caused by the travel of an anti-friction roll U_2, on the rear end of the pivoted finger, over a cam V_2, on the bearing of the shaft. The shaft is rotated by the turning of a bevel pinion *W* on the shaft through the action of an intermittent gear. The necessity of drawing the fingers backward to accomplish the movement between Figs. 4 and 6 was avoided by causing the tied bundle to have a motion away from the fingers as it is expelled from the machine, the relative motion between the fingers and the knot being the same as if the fingers drew back.

Thus the accomplishment of a seemingly almost impossible function was rendered mechanically simple by an evolution from the human hand, after an exhaustive and ingenious analysis of the conditions involved.

ALCOHOL AS A FUEL FOR GAS ENGINES.

Abstract of article by H. Diedrichs, in International Marine Engineering, July, 1906.

Ethyl alcohol, whose chemical formula is C_2H_6O, may be made in various ways, but the commercial alcohol of to-day is the result of fermentation, generally of grape sugar, in the final stage. The raw materials are various; they may be divided into three classes:

1. Those containing starch, *e. g.*, potatoes, with 15 to 24 per cent starch; rye, with 50 to 56 per cent starch; corn, with 60 per cent starch.

2. Those containing sugar, *e. g.*, sugar beet, with 8 to 18 per cent sugar; sugar cane, with 12 to 16 per cent sugar.

3. Those containing alcohol, *e. g.*, wine with 9 to 16 per cent alcohol.

The method of manufacture, of course, varies with the raw material, but need not be described in detail here. Theoretically, 100 pounds of grape sugar should yield 51 pounds of pure alcohol; in reality the yield is from 1-5 to 1-3 less than this amount.

The heating value of alcohol can not be accurately computed from its chemical composition, because nothing definite is known of the arrangement of the atoms entering the composition. We therefore have to depend upon the calorimeter. The figures determined for absolute alcohol by various experimenters are as follows:

	Higher Heating Value per pound.	Lower Heating Value per pound.
Thompson	13310 B. T. U.	12036 B. T. U.
Favre & Silberman	12913 B. T. U.	11664 B. T. U.

The value 11664 B. T. U. is the one most generally used. Absolute alcohol has a specific gravity of 0.7946 at 59 degrees F., so that one gallon of pure alcohol weighs 6.625 pounds, and has a lower heating value of 77,274 B. T. U.

One pound of C_2H_6O contains 0.522 pound carbon, 0.130 pound hydrogen, and 0.348 pound oxygen.

According to this, there will be required for the combustion of one pound of absolute or 100 per cent alcohol

$$\frac{(0.522 \times 2.66) + (0.130 \times 8) - 0.348}{0.23} = 9 \text{ pounds of air.}$$

This is the equivalent of 111.5 cubic feet of air at 62 degrees F. per pound of C_2H_6O. Commercial alcohol is never pure, but contains a certain quantity of water, the admixture being measured according to volume per cent. Thus, 90-per

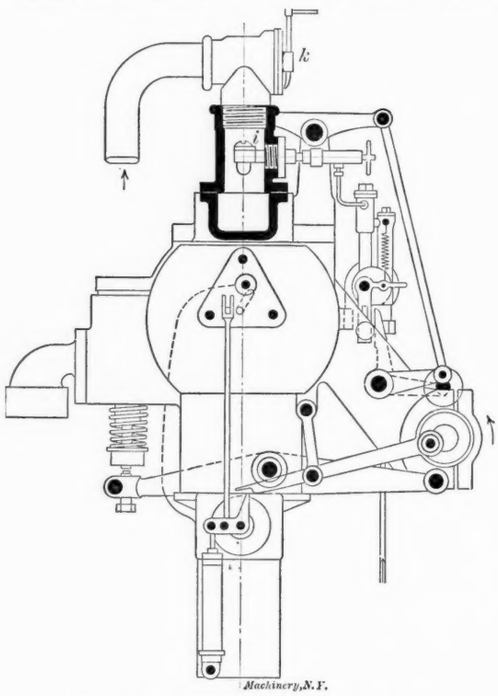


Fig. 1. Valve Mechanism of the Deutz Engine.

cent alcohol means that the mixture carries 10 per cent by volume of water. The heating value of such alcohol is correspondingly reduced from that of 100-per cent alcohol according to the following table, due to Schöttler:

Absolute Alcohol Volume, per cent.	Specific Gravity.	Absolute Alcohol weight, per cent.	Lower Heating Value per pound. B. T. U.
95	0.805	93.8	10880
90	0.815	87.7	10080
85	0.826	81.8	9360
80	0.836	76.1	8630
75	0.846	70.5	7920
70	0.856	65.0	7200

It is required by law, in countries where alcohol is now used

in the industries, to so fix the fuel that it is rendered undrinkable. This process is called "denaturizing" alcohol. Several different materials are used to denaturize ethyl alcohol; wood alcohol, benzine, and benzol being the most common.

There is a second reason why benzol is used. Under certain conditions acetic acid is formed as a product of combustion of alcohol, and this causes rusting of the engine parts. This action takes place only when there is an insufficient supply of air, and the surest way to prevent rusting is to have

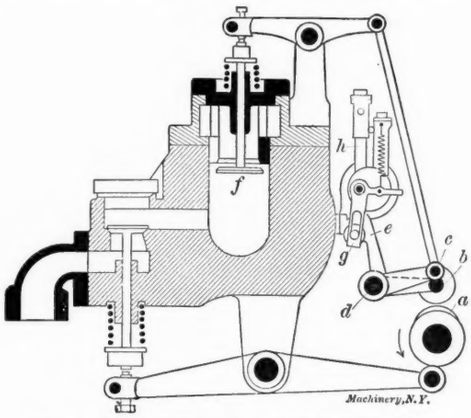


Fig. 2. Section through Valves of the Deutz Engine.

an excess of air and a perfect mixture of the alcohol vapor with it; but it is a good safeguard to use benzol, as it prevents the oxidizing action. There is one objection to its use, however, and that is that it destroys the odorless quality of the exhaust of pure alcohol.

The engines used with alcohol do not differ materially from the ordinary gasoline machine. As a matter of fact, any gasoline or gas engine can be run with alcohol if only proper means be provided to form the fuel mixture. The first trials with alcohol were made on liquid fuel engines. It was soon discovered, however, that the efficiency of operation could be materially increased if the compression were increased above

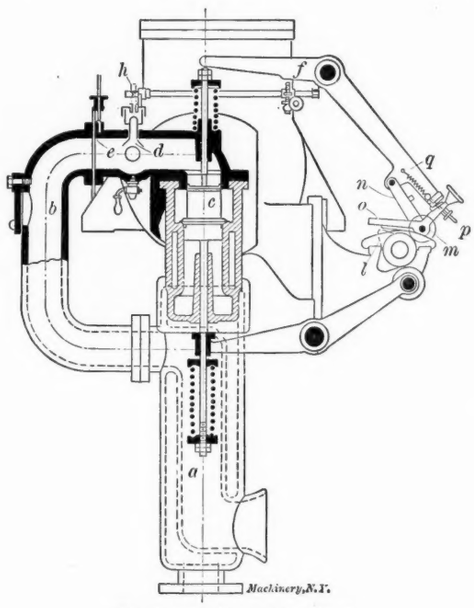


Fig. 3. The Altman Vaporizer.

that possible for gasoline. Hence this is the main point of difference between gasoline and alcohol engines. The other point is one above mentioned, *i. e.*, that a different carbureter or vaporizer is required.

Very little has been done in this country with alcohol engines. Therefore, we have to look to Europe, especially to Germany and France, for information on this subject.

Regarding the fuel mixture with alcohol, it is less volatile than gasoline, but easier to handle than kerosene. In nearly all the vaporizing devices for alcohol, the agency of heat, usually the exhaust heat of the waste gases, is used to aid in the formation of the mixture. This scheme has the drawback that no heat is available at the start when the engine is cold, and it is next to impossible to start a cold engine on alcohol. To avoid an open flame, to start the engine, which is dangerous and cumbersome, the engine is started in most cases with gasoline, and after a few strokes, by throwing a lever, it is changed over to alcohol. The time required to heat up the parts of the engine sufficiently to change over to alcohol varies from about one to six minutes.

Based on the manner of heating, vaporizers are divided into three classes as follows: 1. Those in which no heat is employed. 2. Those in which the air is preheated. 3. Those in which the mixture is heated and superheated.

Of the first type is the Deutz, Figs. 1 and 2. When the engine is regulated by the throttling method, and not by the hit-and-miss system, it has been found that no preheating of air or fuel is required. The reason for this is, undoubtedly, that in a hit-and-miss engine, under less than normal load, a succession of misses cools the cylinder so far as to throw down some of the alcohol vapor on the next explosion, unless it is superheated. The Deutz engine is governed by throttling. The inlet valve, *f*, is actuated through the levers shown, by the cam, *a*, which is of taper form and under the control of the governor. Upon the position of *a* depends the length of time the valve, *f*, is open. Through the bell crank, *c d e*, the cam also acts upon the plunger of the fuel pump, *h*, operating in such a way as to cause suction during the first part of the cam movement, and pumping of the liquid during

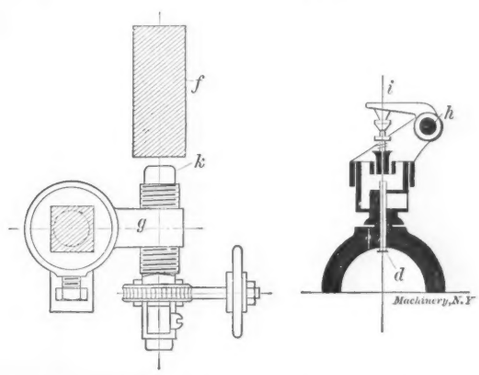


Fig. 4. Charge Regulator and, Fig. 5, Fuel Valve of the Altman Engine.

the second. Thus the fuel is injected during the second half of the suction stroke only, insuring a rich mixture around the igniter. The alcohol is forced through the sprayer or atomizer, *i*, Fig. 1, into the current of air which enters through the valve, *k*. Thus no preheating whatever is done, but the atomizing is thorough; and the ports into the cylinder are as direct and short as possible, hence no vapor is thrown down.

The Altman vaporizer, Fig. 3, is of the second class. The air pipe *a—b* is surrounded at its lower end by the exhaust pipe; the air is thus preheated by the exhaust gases. A regulating valve for the air is placed at *e*. This, when drawn upward, decreases the amount of air passing, but always makes the air current strike through the upper part of the pipe, in this manner directing it always against the fuel nozzle, *d*. The inlet valve, *c*, is operated by the lever, *f*, actuated by the cam, *l*, through the pendulum hit-and-miss governor, *o m p*. This valve lever, *f*, at the same time opens the fuel valve, *d*, through the reach rod shown and the finger, *h i*, Fig. 5. How this is done is shown in Fig. 4. The lever, *f*, on being depressed, forces down the point of the screw, *k*, thereby turning the reach rod about its axis, which depresses the point, *i*, Fig. 5, opening the valve *d*. The amount of opening depends upon the position of the screw, *k*, and this can be very finely adjusted by the worm and wheel arrangement shown. In this vaporizer the fuel supply is atomized partly by the current of air, and is afterward vaporized by the heat of the preheated air.

The following three vaporizers are of the third class. Fig. 6 shows the Swiderski-Longuemarre. Here also the exhaust gases are used for heating. They pass through the annular

chamber, *a*, and their action is aided by the radiating webs, *b*—*b*. The float, *d*, maintains a constant level in the supply chamber. From this chamber the flow of alcohol is regulated by the needle valve, *f*. The liquid flows into the space *g*, and overflows through a number of small openings, *h*—*h*. Air entering through *i* is made to pass partly outside, partly inside the concentric spaces created by the sleeves *k*. The amount of air passing outside is regulated by the openings *n*—*n*, which are controlled by the lever *l*. The air currents passing upward carry along with them some of the liquid, the

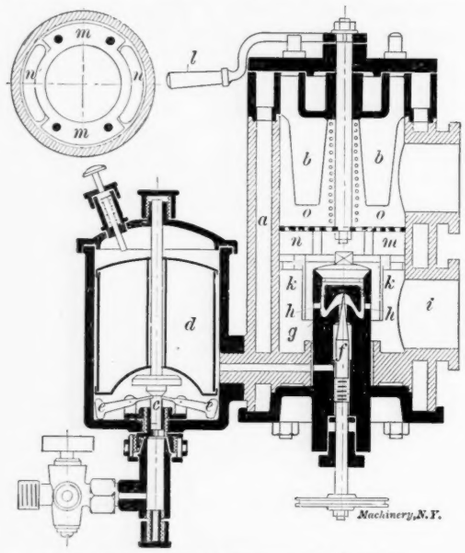
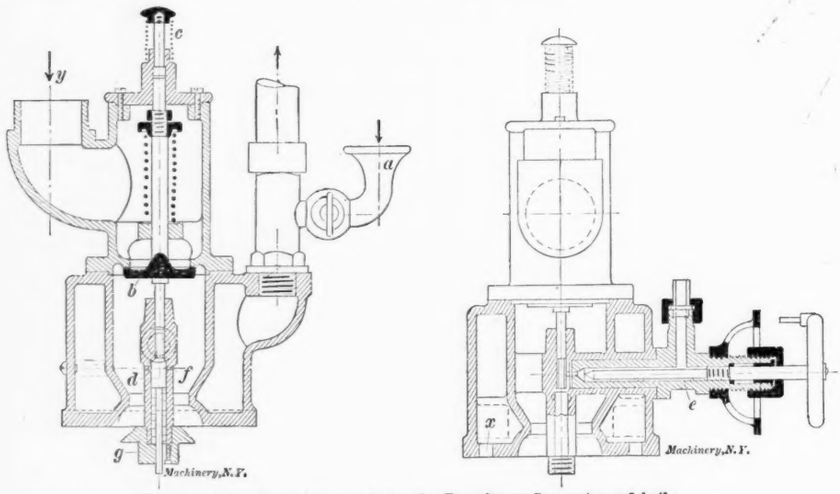


Fig. 6. The Swiderski-Longuemarre Vaporizer.

mixture being heated by the exhaust gases in *a*. The perforated plate, *o*, tends to aid in forming a uniform mixture.

The vaporizer of the Dresdener Gasmotorenfabrik is shown in Figs. 7 and 8. The warm cooling water of the engine is used for heating. It enters the water space at *x*. Air enters at *y*. The inlet valve, *b*, is automatic. It may be pushed down at will at the start by pressing down on the projecting stem, *c*. The downward movement of the inlet valve opens the fuel valve, *d*, to which alcohol is furnished through the needle valve, *e*, Fig. 8. Through a number of fine openings



Figs. 7 and 8. Vaporizer made by the Dresdener Gasmotorenfabrik.

the fuel flows into the current of air and is carried along with it, the thorough mixing being assisted by the current striking the cone *g*.

In contradistinction to the Dresden vaporizer, the Durr, Fig. 9, produces a highly heated mixture. The air enters at *x* and its amount is regulated by the throttle valve, *a*. The inlet valve, *b*, is automatic. Alcohol is supplied through the needle valve, *c*, as shown, so that when *b* is closed no flow of alcohol takes place. The current of air charged with alcohol particles passes down through *d*, up the annular space, *e*, and out at *y* to the cylinder. The exhaust gases enter at *z*, and by means of baffle plates are made to take the course shown by the arrows, through the space *f*. Further, the space *e* is filled with a large number of metal spirals, which connect the outside wall of *e* with its inside wall, thus furnishing a large heated surface to the passage of the charge, and facilitating the transfer of heat from the space *f* to the space *d*.

Finally, Fig. 10 shows what may be called a double float carbureter, which is the form that alcohol vaporizers are likely to take. This is used on the Marienfelde machines. Assume that the chamber *a* is used for gasoline, *b* for alcohol. The needle supply valves can be held closed by the springs *c* and *d*, as shown.

On starting with gasoline, the chamber *a* is used. Spring *c* is pushed aside so that fuel can enter, being kept at constant level by the float. The valve, *g*, is so set that the path is open for the air from *h* past the gasoline nozzle, *e*, through *g* into the cylinder. At every suction stroke the inrushing air is then charged with gasoline issuing in a small jet from *e*. If it is desired to change to alcohol, spring *c* is pushed into place, spring *d* is pushed aside, and valve *g* is thrown over into the position shown Fig. 10, all the work of a moment. The air supply to this vaporizer is preheated.

It is quite evident from an examination of the vaporizer above described that the final temperature of the mixture is different in the different devices. Upon this temperature, however, depends in a great measure the only other point of difference between gasoline and alcohol engines, i.e., the amount of compression. All other things being the same, that fuel mixture entering the cylinder at the highest temperature will soonest give rise to preignition, under an increase in compression. High temperature of charge also affects engine capacity unfavorably. It therefore becomes important to determine approximately the *lowest* practical temperature of vaporization, and the heat necessary.

The amount of heat required depends upon the amount of alcohol (and its purity) per pound or cubic foot of air. Assuming that 90-volume-per-cent alcohol is used, the theoretical amount of air required for perfect combustion is 7.8 pounds. Assuming an excess of 50 per cent, which is a desir-

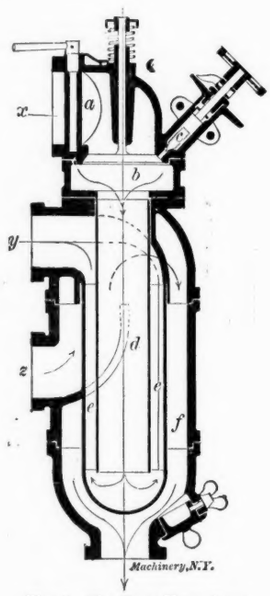


Fig. 9. The Durr Vaporizer.

able allowance, 1 pound of 90 per cent alcohol would require in round numbers, 11.7 pounds of air. With the air temperature at 60 degrees F., and the atmospheric pressure, this amounts to 0.0065 pound of 90 per cent alcohol per foot of dry air. Ninety per cent (volume) alcohol is equivalent to 87.7 (weight) per cent, so that one pound of air will carry, according to the above assumed ratio of mixture, 0.075 pound of absolute alcohol, and 0.010 pound of water.

To compute the air temperature required so that it may take up the above quantities of alcohol and water vapor, we must know the relation between the temperature and the

degree of saturation. This relation is given in the following table:

Temp. degs. F.	Vapor Tension inches Mercury. Alcohol Vapor.	Water Vapor.	1 pound of Air contains in Saturated Condition, in pounds At 28.95 inches. Alcohol Vapor.	Water Vapor.	At 26.05 inches. Alcohol Vapor.	Water Vapor.
50	0.950	0.359	0.055	0.008	0.061	0.009
59	1.283	0.500	0.075	0.011	0.084	0.013
68	1.733	0.687	0.104	0.016	0.117	0.018
77	2.325	0.925	0.144	0.022	0.162	0.025
86	3.090	1.240	0.200	0.031	0.227	0.036
104	5.270	2.162	0.390	0.063	0.450	0.072
122	8.660	3.620	0.827	0.135	1.002	0.164

Assume that the air is at a temperature of 59 degrees and just saturated. At a pressure of 26.05 inches of mercury this would correspond to 0.013 pound of water per pound of air in its initial condition. Now, in the case of the average mixture above computed, the temperature must be high enough to vaporize an additional 0.010 pound of water, making the total 0.023 pound that the air must contain per pound. It is seen from the table that a temperature of 77 degrees is quite sufficient to do this. It is also seen that at this temperature the air may take up 0.162 pound of absolute alcohol, while the quantity in the above mixture is only 0.075 pound per pound of mixture. At a temperature of 77 degrees the mixture ready for the cylinder may therefore contain the alcohol vapor in a state of some superheat. If the temperature of the walls with which the mixture comes in contact is not less than 77 degrees, no fear of condensation of alcohol vapor need be entertained.

The heat required to convert the liquid alcohol into vapor for temperatures above 32 degrees F., according to Regnault, is as follows: At 32 degrees F., 425.7 B. T. U. per pound; at 68 degrees F., 453.6 B. T. U. per pound; at 122 degrees F., 475.2 B. T. U. per pound; at 212 degrees F., 481.1 B. T. U. per pound.

The specific heat of liquid alcohol is close to 0.6, so that in order to convert the quantity of 90 volume per cent alcohol contained in the assumed mixture, to alcohol vapor at 77 degrees F., would require, approximately, assuming the liquid alcohol at 60 degrees F., 44.1 B. T. U. Now, the heating value of 90 volume per cent alcohol has been shown to be 10,080 B. T. U. per pound, so that the heating value of one pound of the assumed mixture will be $0.075 \times 10{,}080 = 756$ B. T. U. The heat of vaporization required, therefore, is $44.1 \div 756 =$

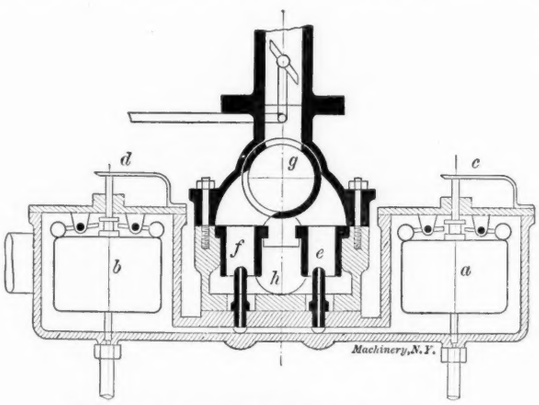


Fig. 10. The Marienfelde Double-float Carbureter.

5.8 per cent of the heating value of the fuel. It can be shown that this amount of heat is easily obtained from the exhaust gases.

If, on the other hand, the mixture and not the air is heated, then the walls need have a temperature only sufficiently higher than 77 to transfer the required amount of heat for vaporization to the mixture in the time available.

It is not desirable to impart a high temperature to the mixture, because then it cannot be compressed to as high a point, and, therefore, the efficiency will be lower. The best results are obtained in practice with a compression pressure of about 180 pounds, which gives a maximum explosion pressure of about 450 pounds.

The design of alcohol engines does not differ much from that of gasoline machines. Fig. 11 shows a two-cylinder launch engine built by Marienfelde. Alcohol is contained in the vessel *a*, which is filled through a strainer, *b*. The tank *a* is kept under a certain definite pressure by means of the exhaust gases, which force the alcohol into the left-hand float chamber of the vaporizer. Part of the exhaust gases pass through the strainer *f*, the check valve *h*, and the pipe *e*, to the fuel tank. *g* is a safety valve, so that by means of this, and the check valve *h*, a constant pressure is maintained on the liquid in the tank. The inlet valve, *i*, is automatic, while exhaust valve *k* is mechanically operated. The fresh air passes through a heater surrounding the exhaust pipe and is thus preheated on its way to the vaporizer. Ignition is pro-

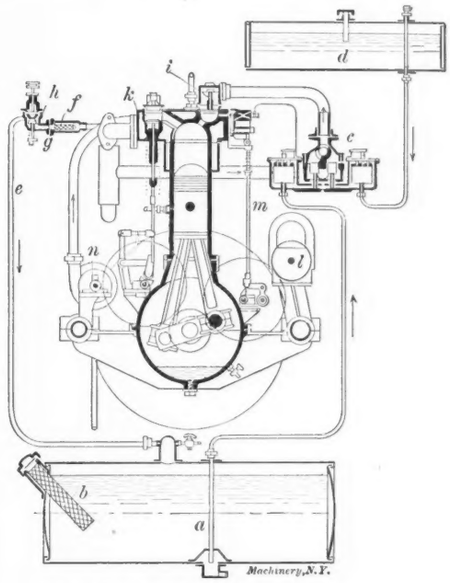


Fig. 11. Two-cylinder Marienfelde Launch Engine.

duced by the electro-magnetic apparatus *l*, *m* being the make-and-break gear. Regulation is effected by the hit-and-miss system. *n* is a small rotary pump to furnish circulating water for the jacket. The supply of gasoline required to start the machine is kept in a tank *d*, at higher level, so that the fuel is supplied to the right-hand float chamber by gravity. The operation of the vaporizer was explained under Fig. 10.

The following table of dimensions of Marienfelde engines gives some idea of the size of the machines:

Maximum Brake Horse-power.	R. P. M.	Cylinder Diameter, Inches.	Stroke, Inches.
8.0	220	6.70	11.80
13.2	220	7.90	14.20
21.0	202	9.85	15.75
24.5	200	11.00	15.75
30.0	200	13.80	15.75

As to the cost of operating alcohol engines it does not appear that they are likely to compete with gasoline unless the price of alcohol is made much lower than at present seems probable. The efficiency of gasoline engines can be estimated at 23 per cent as a maximum. The efficiency of alcohol engines is given at about 31 per cent. If gasoline and alcohol are taken at 15 cents per gallon, the cost of 1,000 B. T. U. for gasoline will be 1.35 cents, and for alcohol it will be 2.19 cents, owing to the fact that the heating value of the former is higher, the actual figures being as follows:

Gasoline, B. T. U. per pound..... 19,000
Alcohol, B. T. U. per pound..... 10,080

It is seen at once that alcohol is saddled at the outset with a very serious handicap in the way of greater specific heat cost, as compared with either gasoline or kerosene. To be on a par, therefore, regarding cost of operation, the thermal efficiency of the alcohol engine would have to be $\frac{2.19}{1.35} = 1.62$ times greater than that of gasoline, and $\frac{2.19}{1.02} = 2.15$ times greater than that of kerosene, everything else in the way of engine losses being the same.

W. B., Jr.

PICKLING CASTINGS.

A writer in *Obermayer's Bulletin* says that from the machine shop workmen's standpoint there is a decided difference between castings which have been pickled and those which have not. No establishment that has used thoroughly pickled castings will be likely to be satisfied without pickling. Tumbling is not a substitute for pickling, as it does little toward removing the scale, but tumbling before pickling is good, as it saves the pickle. Pickling without tumbling is better than tumbling without pickling, so far as the wear of the tools is concerned. The wear of tools and the time required for resharpening and resetting is much greater when used on sandy and scaly castings than on those which have been thoroughly pickled. When this fact is thoroughly appreciated and the time-saving effected by pickling is known, the cost of the process cuts a small figure.

There are two somewhat different processes employed for pickling castings. For one process a lead-lined wooden tank is provided of size and shape determined by the size, shape and quantity of castings to be handled. With a tank 6 feet long, 3 feet wide and 2 feet deep, a large quantity of castings can be pickled. This tank should preferably be sunk a foot or so in the ground and from one of the long sides a tight wooden platform, say 6 feet wide and 12 feet long with raised strips on the edges, should extend back. The platform should have a pitch of two or three inches to the foot toward the tank.

The pickle should be made 1 part vitriol to 4 parts water. It is a common mistake to think that more vitriol will hurry matters and do the work more thoroughly, for the reverse is the case, as an excess of vitriol retards the action and therefore should be avoided. In preparing the pickle the water is put in first and the vitriol is added gradually, during which process the water heats up. Fill the tank to within 6 or 4 inches of the top. The articles to be pickled, if of convenient size to handle, are simply dipped in the pickle, so that they are wet all over, and then laid on the platform to drain and dry. If the castings are too large or too heavy for dipping, they are laid on the platform and the pickle is then poured over them with a dipper. They should be turned as much as necessary to wet them all over, and none of the castings should be left so that the pickle has a chance to settle in pockets or places that will not drain. The castings are then left for eight or twelve hours, when they will be covered with a white powdery substance. It is only necessary to dip the castings in boiling hot water, or to pour the hot water over them until they are thoroughly cleansed of the acid, and when they are dry, the process is completed. A hot water tank is, of course, provided, with a steam pipe for heating the water. This water should be renewed frequently so the acid will be thoroughly removed. An additional refinement is to provide a hot potash or soda bath before the final rinsing in clean water.

To pickle by the second process, tanks are provided of sufficient capacity to submerge the castings for several hours; sometimes they may remain in the pickle over night. When taken out they should be rinsed at once in an adjoining tank of clear water, or better, in two tanks in succession. The pickle for this slow process should be much weaker than for the first process described, the proportion of vitriol to water being about as 1 to 10.

* * *

CALCULATING CENTRIFUGAL FORCE.

W. H. ACKER.

"Centrifugal force," as it is somewhat vaguely called, is not really a force residing in the revolving body and tending to urge it away from the center; it is rather the extraneous force which has to be exerted to restrain the body in its circular path, and prevent it from following the tangent direction which it constantly tries to take in accordance with Newton's law that a moving body will continuously follow a straight line, unless acted on by some outside force. This restraining force is directly proportional to the radius of the circle described by the center of gravity or center of mass of the revolving body, its weight (or more strictly, its mass), and the square of the number of revolutions per minute. It may be calculated by the formula:

$$F = 0.000341\ W\ R\ n^2$$

in which

F = centrifugal force, in pounds,

W = weight of the revolving body in pounds,

R = radius of circular path described by the center of mass of the revolving body in feet,

n = number of revolutions per minute.

The accompanying diagrams (see Supplement) were prepared to give directly without calculations the centrifugal force of one pound for various radii and revolutions per minute. The way in which they are used will be readily understood. From the graduations at the left the horizontal line corresponding to the given radius, in feet or inches, is located. This line is followed toward the right until it intersects the diagonal line which corresponds with the required number of revolutions per minute. From this point of intersection a vertical line is dropped to the base margin, where the centrifugal force is directly read in pounds. This result, multiplied by the weight of the body, will give the required force for the case in hand.

It will be observed that the diagonals for the rate of revolution are terminated by a curve at the points where the intersections give a velocity of 5,000 feet per minute. This velocity is about the limit for cast-iron flywheel rims and similar parts, whose strength can be shown to be a function of the velocity and the physical properties of the material only. For speeds greater than this, each individual case should be calculated from data giving exact information on every point required.

As a simple case, suppose it is required to find the centrifugal force in the rim of a flywheel used on a gas engine. The rim of the flywheel weighs 500 pounds, the mean radius is 3 feet and the speed is 350 R. P. M. Referring to the curves (see Supplement) we find the centrifugal force per pound at 3 feet radius and 350 R. P. M. to be 126. Hence the centrifugal force in the rim is $126 \times 500 = 63{,}000$ pounds. This force is resisted by the two sections of the rim at the extremities of a diameter. A suitable factor of safety having been applied, we readily obtain the sectional area of rim necessary, knowing the tensile strength of material used.

Supposing it is required to find the centrifugal force exerted by the knife of a wood planer, the knife weighing 28 pounds, its center of mass being at a radius of 5 inches, and running at a speed of 1,800 R. P. M. From the curve sheets we get the centrifugal force per pound to be 460, at 5 inches radius and 1,800 R. P. M., and the total centrifugal force is $28 \times 460 = 12{,}880$ pounds. Hence the tap bolts holding the knives in place must be of sufficient size to overcome this force, allowing a suitable factor of safety.

Supposing it is required to find the centrifugal force exerted by a field coil on a revolving field generator. Weight of coil 42 pounds, R. P. M. 100, and radius to center of mass of coil 10 feet. From the tables we obtain a value of 34 for the centrifugal force per pound, and the total centrifugal force is $34 \times 42 = 1{,}428$ pounds.

The values as obtained from the curve sheets will be sufficiently accurate for all computations of this kind, as in all cases a large factor of safety is employed in proportioning parts to withstand the strain.

* * *

The Japanese Government has recently made considerable changes in its tariff rates, largely necessitated by the cost of their recent war. It is evident, however, from examination of the schedule, that the duties of the various articles of commerce have been arranged with the idea, not only of yielding a sufficient revenue, but of protecting, as well, such Japanese industries as seem capable of development. Locomotives and tenders are charged 20 per cent *ad valorem*; the rate of boilers, steam engines, textile machinery, electrical machinery, machine tools, etc., is 15 per cent *ad valorem*. A number of manufactured articles in which the Japanese have attained considerable efficiency have been put in the high duty class. Watches, spectacles, photographic apparatus, etc., are charged as high as 40 or 50 per cent.

A COUNTRY MACHINE SHOP.

R. E. F.

With my ears singing from the rattle of heavy trucks on the paving stones and the rumble of the elevated trains that grind past the windows of our shop, I read the "Wail from New Jersey," which Mr. Press contributed to the June issue. The pathos and poetry of the appeal from the machinist over across the North River struck a responsive note in my breast, and as soon as my yearly vacation week came around I hiked back for a look at the country shop where I worked before the fascinations of the metropolis lured me away. The shop is still there, all right, with the surrounding trees and the mill pond and dam. The plant seems to have spread out some,

Fig. 1. The Shop from across the Mill Pond.

however, and there are nearly twice as many men as there used to be when I worked there, which was not so very long ago, after all.

We had lots of fun getting this shop going. Originally there were only two of us, the proprietor and myself. He had worked out a scheme for an automatic machine for making paper boxes, and I was trying to help out a bit on the design, and the equipment of a little shop to make them in. After the drawings and the experimental machine had developed to a point where we felt safe about them, the boss and myself put on our coats one afternoon and started out shop hunting. The town was not a very large one, so the available locations were not so many as to confuse us in this enterprise. The situation that took our eyes was the one where was located the shop shown in Fig. 1. It had originally been the weaving department of a cotton mill of which the other buildings were located a considerable distance down stream. It was run by water power from a brook fed by a storage reservoir of sufficient capacity to insure us a supply of water in any ordinary dry season. The buildings were in pretty poor shape, having been out of use for a dozen years, so when the arrangements which gave us the control of the property were finally made, there was plenty of work to do before the place was in fit condition to use.

After getting a number of men at work covering the roof, leveling up the floors, and glazing the window frames, we started to investigate the condition of the water wheel which had lain so long submerged without attention or repair. "Henry," a "down-east" combination millwright, toolmaker, carpenter and blacksmith, who had cast in his lot with ours, undertook this investigation with great enthusiasm. The manhole of the waterwheel casing was pretty slim, but Henry, like most of his race, was still slimmer. So, after getting him into a pair of hip boots, we opened the cover and he wriggled through the opening and disappeared. Not for long, however. Sputtering and gasping, he soon came in sight again and explained that he had been unable to find the bottom and had concluded to come to the surface for further deliberation.

It was evidently necessary to lower the level of the water below the wheel before we would be able to clean out the accumulated rust and mud from inside the casing. The water at the foot of the dam formed a mill pond for another power plant below us, so I set off downstream to interview the man in charge as to the possibility of lowering his pond a little to allow us to get at the wheel. The caretaker, however, was somewhat crusty and was unwilling to lower the level of his pond, fearing that he would not have power enough if he did so. After looking the plant over, it was evident that this fear was entirely groundless, as the wheel was only running at a small fraction of its capacity and the greater part of the stream was running over the dam. Argument failed to impress him, however; the owners of the place were in a distant city and difficult to reach, so we had to devise some way to regulate the height of this lower pond from our place up stream.

This seemed at first a rather difficult proposition, but it worked out very easily after all. We went home one night with the waste gate of the dam left open so as to drain the pond and stream above us. On my way to the shop the next morning, while still nearly a mile away, my nose was assailed with the odor of drying pond mud and exposed aquatic vegetation, so it was immediately evident that the pond had been drained. Hastily, and in momentary dread of a visit from the rural board of health, we closed the gate again, thus allowing the pond to fill up, taking the opportunity meanwhile to examine and repair the rack at the entrance of the penstock.

Of course the great mass of the water which had come over during the night had gone over our lower neighbor's dam. When the gate was closed again he had no greater supply on hand than usual, so his wheel had to use what little was left in the small pond below us. This was in this way drained out gradually, until it was lowered to a point which permitted full examination of the interior of our wheel; then enough water was allowed to flow through the gate to keep the level constant at this point, thus assuring our neighbor of a sufficient supply of water. This was a rather arbitrary proceeding, and might have caused trouble for mills lower down which were running at their full capacity, but circumstances were such that we could serve ourselves in this way without injuring any one else.

Besides being filled with mud, the water wheel was found to need repairs. Two short racks which meshed with pinions

Fig. 2. The Cool Outlook from the Tool Room Window.

on the gate wheel shaft and were used for raising and lowering the circular gate, had rusted away so that only the first few teeth were intact. For this reason it was impossible to raise the gate more than about one-quarter of its proper height. An order was given to the makers of the wheel for such repair parts as were necessary for this job, and these were put in place. Although the wheel was nearly twenty years old the position of the drilled holes, and the fits in general were so nearly correct that we had a very high idea of the management of the shop that furnished the wheel and the repair parts.

One of the interesting things about this old shop was the line of shafting which had been used to drive the looms when it was run as a weaving shed. This shaft was located beneath the floor the whole length of the shop, and its sections were

coupled together with screwed joints in about the same way that steam pipe is fitted up, except that there were no left-hand threads and no unions. The arrangement of the masonry and the supporting structure was such that this shaft had to be assembled or disassembled from one end. How in the world the mechanic who fitted that place up expected to remove or repair any one of the dozens of solid hangers or scores of solid pulleys on that length of shaft, it is hard to say. To replace a hanger or pulley on the center of the line, he would have to commence at one end, unscrew each coupling in turn with all its hangers and pulleys, and take the whole thing down until he came to the length of shaft containing the parts he wished to replace, reversing the operation to put the parts back in position again. We wanted to make use of a short length of this old line as an intermediate jackshaft between the water wheel and the main line on the ceiling of the shop above. After one or two attempts at unscrewing the old rusty couplings we gave up the job, and started the strongest and best-natured boy in our force on the task of severing this length of 3½-inch jackshaft from the rest of the line, with no tools but his muscle and a hacksaw frame with plenty of sharp blades. After this had been accomplished, the ends of the shafts were forced apart until there was no danger of rubbing, when the short length was put in commission.

The floor of the waterwheel pit was composed of heavy beams with only an occasional board. In the spring this room was a favorite place for the boys to soldier, especially when suckers were running. They would rig up any make-shift sort of a spear that came handy, sneak down the two flights of back stairs, and stand near an opening in the floor, ready to land a sucker or any other suitable fish that might happen to come within range. One of the men was quite expert in this occupation—expert, that is, not only in sticking the fish, but escaping the boss as well. One large pickerel that he captured he was especially proud of. To prevent its recapture by any of the other workmen, he fastened it in his locker. One of the boys, however, came into the office and prevailed upon the boss to let him have the duplicate key for a few moments, explaining his intentions meanwhile. He poked a cent piece as far down the fish's throat as he could reach with a long lead pencil, and returned the key. The fisherman had a great story to tell next morning about what his wife found when she opened up his catch.

It is something of a pleasure after all to work in a shop surrounded with green grass and elms and cedar trees, with a water-fall splashing away just outside the toolroom window. There is lots to interest one when he gets tired working. There are fishermen to watch over across on the other bank; one's friends and neighbors occasionally pass by the shop windows and on rare occasions drop in to see one. In winter, sometimes, when the air is just right, the foam at the foot of the falls freezes together into great round "cocoanut cakes," as we used to call them, twelve or eighteen inches in diameter and six inches thick, which swirl around in the open water below the dam and look good enough to eat. Later on, when the below zero weather comes, the falls, with the water below them as well, freeze over solid. Their roar is silenced, and one might almost imagine that the whole stream was congealed clear to the bottom, were it not for the fact that the wheel is still working away and the pulleys are going around as fast as ever. The hours are on the whole a little longer in this country shop, but no one seems to mind that particularly. There are not so many workmen as there are in the big shop in the city, but being fewer they have more interest in the work they are doing. Each man knows all about the whole product of the plant, and is personally interested in this new attachment and that special machine and the order which has to be gotten out day after to-morrow; and so no one objects much to hustling a little and working overtime when it is necessary. Take it all together, the memory of this New Hampshire shop seems to come back to me quite strongly as the springtime of each year returns.

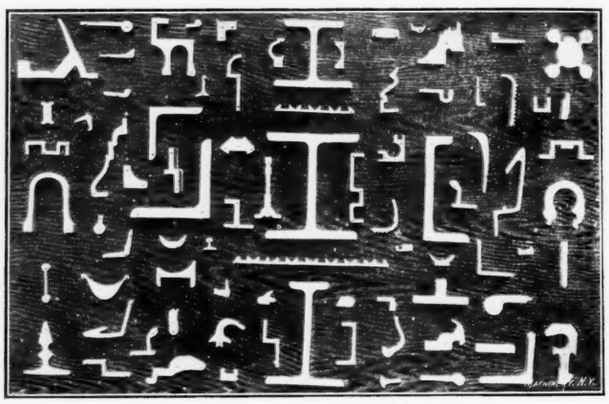
* * *

Large four-cycle gas engines using producer gas may be safely estimated to develop one brake horse-power per hour on one pound of coal; or tersely put: 1 pound, 1 B.H.P., 1 hour.

EXTRUDED METAL SECTIONS.

One of the interesting exhibits at Atlantic City, N. J., on the occasion of the recent Master Mechanics' and Master Car Builders' Associations conventions, was that of the Coe Brass Mfg. Co., Torrington, Conn., showing a number of extruded brass and bronze metal sections, and of billets partially extruded. The accompanying cut shows a few of these sections fastened to an exhibit board. In view of the extensive use that can be made of these sections, a short description of the process and the metal will not be without interest.

The process of making metal shapes by extrusion is similar to that of forming lead pipe, but is, of course, attended by considerably more difficulty, inasmuch as the alloys of brass and bronze have to be heated to a comparatively high working temperature, whereas lead may be extruded cold. The process was developed abroad, being invented, we believe, by Mr. Alexander Dick of London about twelve or fourteen years ago. By the process of extrusion bars or rods of almost any required cross section may be produced in brass or high tensile strength bronze and so accurately that no machining is afterward required. The process consists of squeezing the heated metal through dies to the required shape by hydraulic pressure (oftentimes as high as 60,000 pounds per square inch). The very high compression to which the semi-plastic material is subjected renders it homogeneous and free from ordinary casting defects. The dimensions of the finished bars are limited by the weight of the billets used, these ranging in weight from 150 to 175 pounds. At the present time the company are to produce at their Ansonia, Conn., plant special shaped bars or rods ranging from light sections of about ⅜ inch diameter and weighing a fraction of a pound per foot to heavy sections 5 or 6 inches in width and weighing several pounds per foot. The length in which these sections can be obtained depends upon the size, it being obvious that the heavy sections must be produced in shorter total lengths than the light sections.



Examples of Extruded Sections.

The word extrusion accurately describes the operation by which various sections are formed. Billets of brass or bronze are formed of cylinders of about 7 inches diameter, and these are heated until of a plastic consistency and then by means of a small crane are placed within a strong horizontal cylinder or container at the front end of which is a die. Upon hydraulic pressure being applied at the rear end of the condenser the plastic metal is forced or squirted through the die, issuing therefrom in a long bar having a cross section corresponding to the hole pierced in the die. Mr. Dick was a long time perfecting the process owing to the difficulty of obtaining suitable material for the construction of the container, die, etc. All these parts have to withstand without yielding a pressure of 25 or 30 tons to a square inch when practically red-hot. The machine consists essentially of a hydraulic press of very massive construction, the principal parts being two crossheads, one holding the hydraulic cylinder and the other at the opposite end arranged for holding the die, the two being connected by two strong columns. Between these columns is the container for holding the billet of heated brass.

As regards the quality of metal produced by this process,

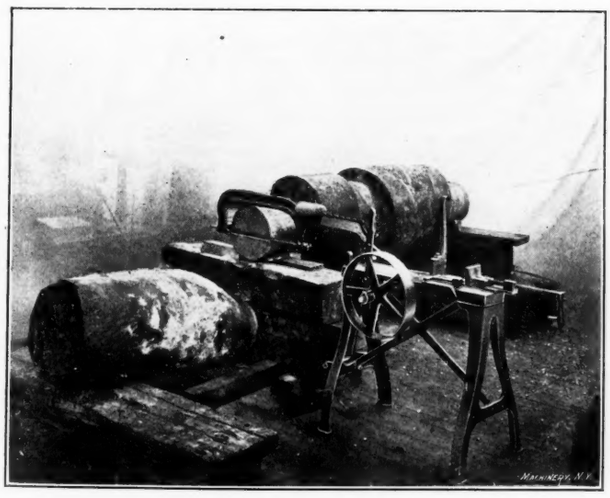
some tests made by the company on naval brass extruded rods for bolt stock showed that the material possessed an elastic limit of 41,600 pounds per square inch and a maximum strength of 63,200 pounds and an elongation of 21 per cent in a length of 8 inches. The reduction in area was 19.4 per cent.

A considerable use that has been found for this metal is in the form of moldings for architectural work. It is well adapted for use in large stores and office buildings, railroad stations, residences, etc., and can be oxidized to give it any color desired. Extruded moldings are also supplied for use in the construction of passenger and sleeping cars, as the metal will take a high finish, is durable, and does not rust out or corrode in service. It is also largely used for step treads, step nosings, platform binding, hinges and door stops, having taken the place of brass castings for these purposes. In fact, extruded shapes made in a free drilling and free milling stock, have superseded castings for many purposes. The metal being perfectly smooth and accurate requires little, if any machining, and is utilized in a great variety of manufacturing lines, small pieces being sawed or milled from special shape extruded brass bars to take the place of machined castings. This affords an efficient and economical means of making small, intricate parts such as cams, dogs, pinion wheels, and various other parts that are required in the manufacture of locks, typewriters, steam turbine blades, telephone and telegraph instruments, switchboards, and other electrical apparatus.

* * *

WHAT THE POWER HACK SAW CAN DO.

Probably there is no other small machine tool ever put on the market that became popular so quickly as the power hack-saw. An illustration of what large jobs this small machine can do is shown in the accompanying cut, the photograph for which was made in the shop of certain customers of the Hoefer Mfg. Co., Freeport, Ill. It shows how one of the hack-saw machines made by the latter concern was adapted to cutting off the riser head of a steel casting for a heavy crankshaft. The regular lathes in the customers' shops being busy, they did not care to take the time or run the risk of cutting off the riser head in any one of them, so a saw frame



A Power Hack Saw Working up to its Limit.

was made for the machine which would take in an 18-inch blade. This frame was turned around end to end, as shown in the cut, and the machine was moved up to the steel forging and driven from the lineshaft. The shaft at the point the riser was cut off is 11½ inches in diameter. It took twenty hours to saw it through, but as there was no particular hurry for the job the time required was not a matter for much consideration. The crankshaft and riser were separated by two cuts, being cut half way from one side and then turned over and cut through from the opposite side. Two saw blades were used up in the operation. The Hoefer Mfg. Co. inform us that no other power hack-saw of a similar type can be reversed and used in the manner shown in the cut.

SAMUEL WEBBER.

REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS.

Samuel Webber was born in Charlestown, N. H., in 1823, and was carefully brought up by his father, a physician, in the outdoor life of a country boy, from a delicate child developing into a strong, vigorous man. He was taught to handle horses, cows, and pigs, to hoe corn, dig potatoes, and saw wood, to take all possible exercise in the open air and to fish and shoot every holiday, thus forming a constitution which has given him a long and busy life. Educated at home, mainly with the intention of a mercantile life, he studied French, Italian and Spanish, with sufficient Latin to ground him fairly in those languages, and with a mathematical taste, inherited from his father and grandfather, which, aided by the immediate proximity of a blacksmith's and wheelwright's shop, turned the current of his life to mechanics, and he accordingly, at the age of seventeen, left home for the city of Lowell, "to seek his fortune" in some of the manufacturing establishments then being constructed.

Here he was fortunate enough to be aided by the friendship of Dr. Samuel S. Dana, the chemist of the Merrimac Mfg. Co., who was then investigating the newly discovered process of electrotyping, and at once put to work on experiments to apply this process to the engraving of copper rollers for calico printing. All the electricity we then had was procured from galvanic batteries, and the young student soon became familiar with the handling of the Smee and other forms of voltaic batteries then in use, but the practical results of the experiments proved unsuccessful. The operation of etching the lines drawn by a diamond point on the surface of a copper roller covered with an asphaltum varnish, which was to be eaten out by the acid liberated by the electric current from a solution of sulphate of copper, proved too slow, and the varnish was destroyed before the lines were sunk deep enough. By reversing the current, it was possible to deposit figures on the surface of the rollers in such points as were protected by the varnish, but here came another difficulty: the deposited copper did not adhere strongly enough to the rollers to bear the mechanical strain to which they were subjected in the printing machines, and after long experimenting, the attempt was abandoned, to be followed by a return to the known method of etching with nitric acid. Here the lines cut by the diamond through the varnish were eaten to the required depth by the acid in a very few minutes, but the work of drawing the lines through the varnish was confined to such lines as could be drawn by a simple ruling machine or by such a machine as is used in drawing the eccentric work commonly used in bank note engraving, and could only be performed with a single diamond. At this time a new factor came into the situation. Milton D. Whipple, an ingenious mechanic and inventor, came to Lowell with a machine for removing the burrs from South

American wool, and learning that the Merrimac Co. were engaged in experiments on engraving, came to them with suggestions for a process of his own. He looked over the matter, proposed a plan for using a number of diamond points, instead of one, dismantled the old eccentric machine, and devised one which should use as many diamonds as the width of the design required to cover the roller, and produced a power-driven machine which answered all the purposes for engraving stripes, checks, and other rectilinear figures. He then turned his attention to a pantograph machine for engraving curved lines, and designs of that character, using as before a multiplicity of diamonds.

In all this Mr. Webber assisted him and derived much valuable information from Mr. Whipple's clear insight into mechanical principles and motions. They spent many months in these operations before succeeding in producing an evenly etched roller, but Mr. Whipple built a machine for grinding all the diamonds to a uniform cutting point. Mr. Webber discovered that the unequal density of the copper rollers was the cause of imperfect work, and cured it by burnishing the surfaces under heavy pressure, until the whole plan became a success and the etching process has been universally used in all the print works in the country.

These things accomplished, Mr. Whipple left Lowell for other inventions, and Mr. Webber, not content to engrave copper rollers as an occupation for life, also sought new fields and accepted an invitation from the late Horace Gray, of Boston, then largely engaged in iron manufacture on Lake Champlain, to investigate that subject in the summer of 1847. Mr. Gray explained the subject in practically these words: "The whole question of the successful manufacture of iron is contained in the letters of a single word—'Colt.' These letters stand for Coal, Ore, Labor, and Transportation, and whoever can master their meaning and catch that colt is assured of a fortune." He proposed that Mr. Webber study the matter theoretically for a short time, especially the chemistry of iron, then visit the works on Lake Champlain and other places in this country and Europe, and decide on the plans for more extensive works.

Mr. Gray's words and insight were prophetic, but his too-extended operations with deficient capital at Lake Champlain brought on his financial failure and stopped the whole project. Mr. Webber, who had spent a short time studying chemistry under Prof. Horsford at Cambridge, found himself entirely adrift, but having studied mechanical drawing in his evenings at Lowell, he soon secured a position as draftsman and assistant engineer at the Bay State mills, then being built at the new city of Lawrence. When the mills were completed, he became assistant superintendent and finally superintendent of them, employing at one time 1,700 operatives.

This mill, the Bay State, commenced operations in 1848, with the manufacture of tartan and other Scotch woolen shawls, and was for a time very successful, but Mr. Webber's health broke down with long labor added to two severe attacks of illness, and he was forced to give up business. He was advised by his physicians to take a sea voyage, and this was accomplished by receiving a commission from the treasurer of the Bay State Mills and the Essex Co. to visit the manufacturing districts of Europe, look into the worsted and linen mills, and see if either branch of manufacture could be profitably introduced into this country. He accordingly left New York in October, 1850, in the sailing packet *West Point*, and landed in Liverpool after an easy voyage of seventeen days.

The following winter and spring months were spent in visiting the mills of England, Scotland, France and Belgium, and examining their processes. He found the introduction of linen to be impracticable, for though the machinery was simple, the processes of preparing the flax for spinning required such an amount of tedious hand labor in retting and hackling the fiber as to render it useless to attempt this branch of manufacture.

With worsted the case was easier; the wool was available in any quantity in the United States and the machinery and its operations were simple. He accordingly purchased for the Essex Co. a complete set of worsted-spinning machinery, together with such other tools, machines and drawings as seemed to him worthy of introduction, among them the drawings of the "link motion" for locomotive engines, then new, and not in universal use. This business took him very well over Great Britain, and included a visit to the iron works at Cyfarthfa and Merthyr Tydvil, to examine the manner of making rails for American railroads. Through the influence of the Hon. Abbott Lawrence, then American minister to Great Britain, he was appointed one of the jurors for the great International Exposition in Hyde Park, then called the "Crystal Palace," in May, 1851, and here he served for three months in company with Gen. Poncelet, the celebrated French engineer, Professor Willis, of Cambridge, and other prominent engineers, examining "machinery and machine tools" and forming the acquaintance of such men as Whitworth, Fairbairn, Nasmyth, Rennie, Scott-Rupell, and other prominent engineers and mechanics. Here Mr. Webber found his early study of French of great value, as it enabled him to serve as an interpreter between the English and Continental judges, some of whom could not speak both languages, in the absence of Prof. Willis, who could.

Returning to Lawrence in the autumn of 1851, the next year was spent in setting up the worsted machinery which he had brought home, and developing its capacity for the intended purpose, but the Pacific Mills, for whose use it was proposed, had already extended their plant to the full employment of the capital, and the project was abandoned for the time being, though successfully carried out a few years later. In the meantime, Mr. Webber had been called to New York to take charge of the arrangements for the proposed exhibition at the so-called Crystal Palace, in the Reservoir Square, now Bryant Park, on 42d St. Here he remained through 1853, allotting the space, installing the exhibits, and finally acting as Commissioner of Juries.

In December, 1853, he went to Indian Orchard, in the city of Springfield, Mass., to take charge of an unfinished cotton mill, which had been abandoned for financial reasons. Here, on procuring fresh capital, he completed the mill, revised and changed the contracts for unfinished machinery, installed the waterwheel and shafting and put the mill in operation in 1854. The financial panic of 1857 caused a suspension of work there, and Mr. Webber was transferred to the position of manager of the Manchester Print Works, at Manchester, N. H. Here his previous experience in Lowell came in play to good advantage, and he remained for six years, resigning the position to take charge of the Portsmouth steam mill at Portsmouth, N. H. In 1861 the Civil War broke out, and Mr. Webber, having been appointed an aide-de-camp to Gov. Berry, of New Hampshire, was very busy for many months, in addition to his regular labors, in raising and looking after troops for the army. He organized and equipped the first New Hampshire battery of Light Artillery, acting under the permission of the Governor and Council, and in company with the Governor, escorted them to Washington in October, 1861. When the war closed in 1865, the enormous fall in prices of materials wrecked the Portsmouth mills, Sea Island cotton, of which they had a large stock, falling from $3 to 80 cents a pound, and Mr. Webber was thrown out of business. He spent some months in various engineering operations, among other things preparing plans for the water power at Bellows Falls, Vt., and in 1866 was appointed assistant appraiser of textile fabrics for the port of New York. Here he remained four years, until a political change in the administration threw the whole board of appraisers out, and he then went to Washington, where he remained some months, revising and correcting the returns of the Industrial Division of the census of 1870.

During Mr. Webber's six years' residence in Lowell, he formed the acquaintance of two prominent engineers, Messrs. Uriah A. Boyden and James B. Francis, and with Mr. Boyden watched the installation of the first Fourneyron turbine, in the mills of the Appleton Co. at Lowell. With Mr. Francis, the acquaintance grew into a lifelong friendship, and from Mr. Francis he received a great deal of valuable information, watching carefully his experiments on the flow and measurement of water, and the tests of power utilized by turbines, and consumed by other machinery. This stood him in good stead, when after his return from the Census Bureau he was invited by Mr. Straw, the agent of the Amoskeag Co., to examine and determine the amount of power actually consumed by

the mills in Manchester which had apparently exhausted their water supply. These measurements were made and resulted in a general reorganization of the Amoskeag power plant, the power consumed being found to be largely in excess of that conveyed by the deeds of water. This was followed by a long series of examinations and measurements in the different cotton and woollen mills in New England lasting several years, and including two sets of tests of the Geyelin-Jonval turbines, furnished for the Manchester water works, the first set having proved too small to supply the necessary power. In 1876 Mr. Webber was appointed one of the judges of the Centennial Exposition at Philadelphia and here he spent several months serving on different groups of judges, and finally conducting a series of tests of all the turbines exhibited, which were only completed on the day the exposition closed.

After this he continued his labors in the measurement of power until in 1879 at the request of Mr. Francis he published a small volume entitled "A Manual of Power" giving the result of his different observations of the tests of turbines and many hundred of measures of the power consumed in cotton and woolen mills with tables of the power required for shafting and belting, to which was later added one on gearing published in the Journal of the Franklin Institute. This "Manual of Power" was published under the auspices of the New England Cotton Manufacturers' Association, of which he was one of the founders in 1865 and of which he is now an honorary member. In 1880, at the invitation of Professors Sweet and Thurston, he met them with a dozen other engineers at the office of the *American Machinist* in New York and there founded the American Society of Mechanical Engineers, now containing two thousand members. To the transaction of this society he has at times contributed various papers and discussions. In the summer of 1880 he was appointed one of the judges of the cotton exposition at Atlanta and after attending to the duties of that post made practical tests of the power of various traction engines, the precursors of the modern automobile.

Returning to Manchester, he removed in 1883 to Lawrence, Mass., to advise with his sons in a machine shop which they had established there, and where he made the calculation and drawings for a portable dynamometer, which they constructed for him, and which has since been called by his name. About this time he went to Augusta, Ga., and tested the power for the turbines in the John P. King mill, it being the heaviest turbine test made up to that date, being nearly 500 horsepower.

In 1884 he was called to New Orleans, where he laid out the power plant for the New Orleans Exhibition, and arranged the engines, shafting and machinery exhibited. This occupied the summer and autumn, and in December he returned to New England by water, coming down the river to see the "Eads jetties" and round through the Gulf of Mexico. In the spring of 1885 he removed to his native town of Charlestown on account of his health, finding it very easy to reach by rail all the manufacturing centers of New England, as well as those of New York, New Jersey and Pennsylvania. From this point he continued his observations for nearly twenty years longer, his last active engineering work being the gaging of the summer water flow of White River at Hartford, Conn., at the age of nearly eighty years.

He has also spent much time in the course of his life in examining steam engines and boilers, testing various forms of the latter, taking indicator cards of engines, noting the value for combustion of various kinds of fuel, and experimenting on the value of lubrication of different kinds of oil.

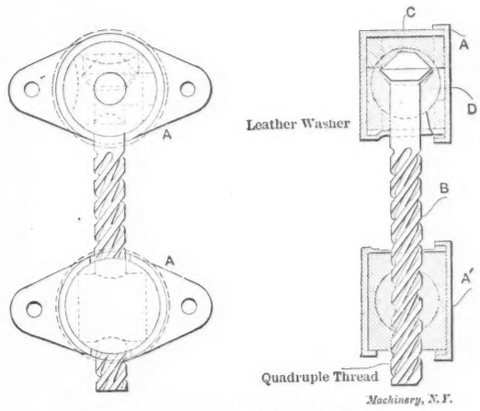
Much time, also, has been occupied in attendance of court and in making the necessary examinations and giving evidence in patent cases and law suits for water rights and damages, and also in examining the flow of streams which the owners proposed, if possible, to make useful as sources of power, visiting both Nova Scotia and Georgia for the latter purposes. He has been a frequent contributor to the technical press for many years, writing on questions of power and its transmission, mill construction and economy and various other topics. He has also been a student of natural history and interested in the fauna and flora of his native State. In 1876 he was appointed chairman of the New Hampshire Fish and Game Commission, and with the late Judge Sargent, of Concord, revised and compiled the fish and game laws of that State. He spent much time examining the lakes and streams of New Hampshire, introduced the fresh-water salmon into the lakes at the head of the Merrimac and Connecticut rivers, and endeavored to restock the Merrimac with sea-going salmon by constructing hatching houses and fishways.

This attempt was unsuccessful, as the fish would not return in any quantity, probably from the pollution of the waters by manufacturing establishments, and the effort was abandoned, but is worth noting. In closing this notice of his labors, he wishes to add, for the benefit of young engineers, the advice once given him by Mr. Francis: "Depend on your own careful observations and measurements rather than on text-books and printed authorities, which are often fallible and of doubtful value."

* * *

EDO SHOCK ABSORBER.

The development of the automobile has caused the breakage of springs on vehicles to be investigated much more thoroughly than had been the case prior to its advent, or perhaps it would be fairer to say that the high speed at which motor-driven vehicles are run so accentuated the trouble of spring breakage that it has assumed much greater importance than under former conditions, and consequently more is being done to prevent it. A leaf spring rarely breaks under the impact of road obstruction but usually on the rebound. When a rapidly moving car strikes a stone the shock is absorbed in the running gear and springs, the impulse not being communicated immediately to the body. But, after the obstruction is passed, the energy stored in the spring throws the body upward and its inertia carries it beyond the elastic limit of the spring, causing the break. A number of shock absorbers have been developed which work on the principle of offering no resistance to compression of the spring but which retard its reaction. An interesting example of these devices is shown in the accompanying cut being the "Edo"



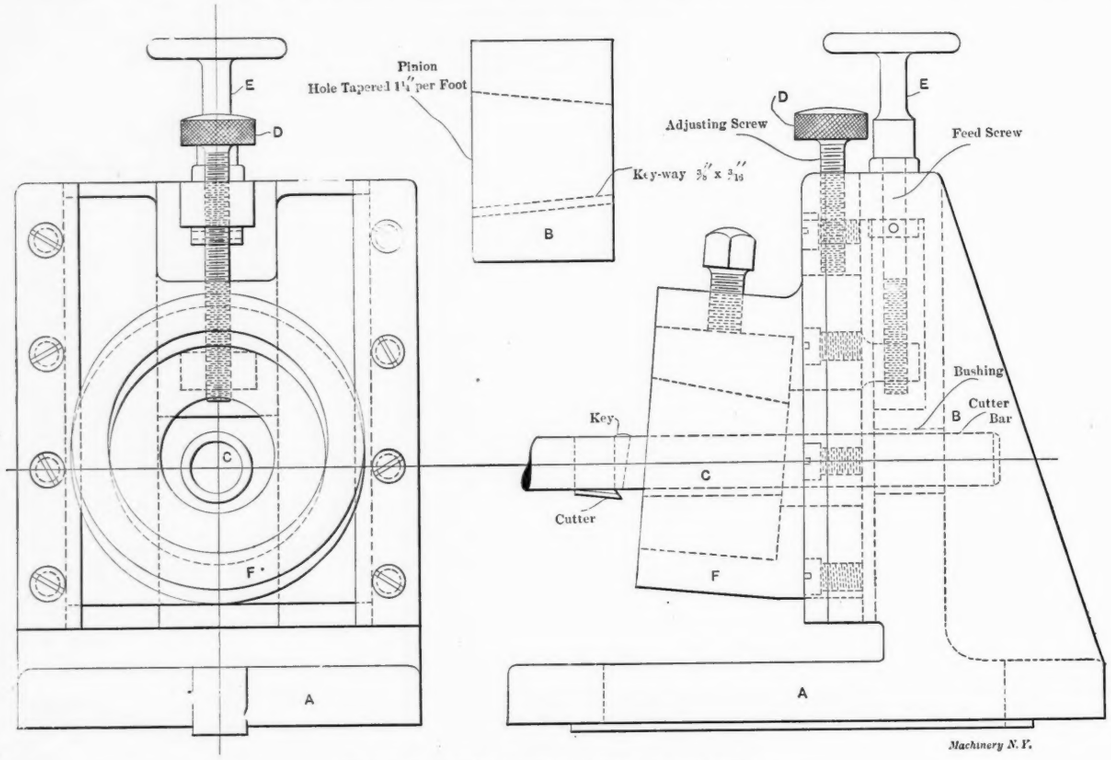
A Shock Absorber for Automobile Springs.

shock absorber applied by Beyer, Peacock & Co., Manchester, England, to a standard 5-ton steam motor truck. The Edo shock absorber is made in the form of a quadruple-thread screw *B* supported at either end by a phosphor bronze fitting *A* and *A'*, one of these being attached to the frame and the other to the axle. The lower bearing for the screw is a long nut, and at the upper end the screw has a cone head. This head is seated so that when the spring is compressed the screw revolves easily, the thrust being taken at the point of the screw at *C*, but the upward movement is retarded by the friction of a leather washer which is interposed between the under side of the head and the seat *D*. In one case the bearing is virtually a point and in the other case it is of considerable diameter, being the under side of the head and, besides, the frictional resistance of the leather is much greater than that of the metallic surface contact in compression. Consequently when the spring is compressed by the car passing over an obstruction there is little resistance by the shock absorber to this action, but its straightening out is retarded so that there is little or no possibility of the momentum of the body exceeding the elastic limit of the spring.

LETTERS UPON PRACTICAL SUBJECTS.

FIXTURE FOR SPLINING KEYWAY IN TAPER HOLE OF PINION.

The cut shows a fixture for cutting keyways in pinions with taper holes. The bushing *B* acts as guide for the cutter bar *C* at one end, the other end being fastened in the shaper ram in the ordinary way. The pinion is held at the required angle by the receiver chuck *F*, which is part of a vertical slide.



Fixture for Splining Keyway in Taper Hole of Pinion.

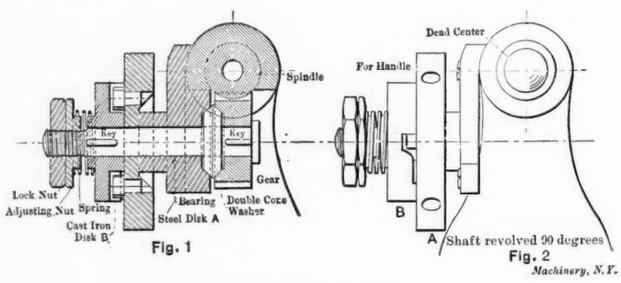
The adjusting screw *D* gives the depth of cut, while the feed screw *E* raises and lowers the work for the cut and clearance when the tool is on the backward stroke. This fixture has given good satisfaction, being adapted to cut different sized pinions by using rings or bushings. I. N. QUIRE.

A QUICK-ACTING LOCK FOR THE TAILSTOCK SPINDLE.

Small lathes are often used for filing and polishing small pieces, or for winding springs and magnet coils, or for performing other operations that require the work to be frequently clamped between the centers and released. The device here described was designed to conveniently and quickly operate the tailstock spindle during such operations. One forward movement of the operating handle serves to advance the spindle until the article is clamped between the centers and locked firmly in that position. A reverse movement unlocks the spindle and withdraws it from the work. The construction of this device is shown in the cut.

The spindle has a suitable rack cut on its under side into which a small gear meshes for driving it. This gear is firmly keyed to one end of a shaft supported in a bearing as shown. The gear and the end of the bearing are recessed for the double cone friction washer. The shaft projects some distance through the bearing at the other end and carries the following parts: At the end of the bearing is a steel disk *A* which may revolve freely upon the shaft, and is provided with two projecting pins of bessemer steel and four holes for the operating handle. Next to this is the cast-iron disk *B* which can slide longitudinally upon the shaft, but is prevented from turning by a key. The disk has two slots shaped as shown in Fig. 2, into which the bessemer steel pins of disk *A* extend. The other side of this disk is provided with a small hub. The end of the shaft carries a nut and locknut. Between the nut and disk *B*, and supported by the hubs of each, are three or four turns of 1-16 inch steel spring.

The operation of the device is as follows: With the parts as shown in the figures the spindle may be considered as being drawn back. The pins of disk *A* are lying in the deepest portions of the slots in disk *B* so that the two disks are in contact. Revolving *A* by the handle inserted in one of the holes, the steel pins move in the slots in *B* and come against the inclined surfaces of these slots, thereby tending to force disk *B* away from disk *A*. This is resisted by the steel spring which prevents disk *B* from sliding longitudinally upon the shaft, consequently *B* revolves with *A* and by means of the key drives the shaft. This revolves the gear on the other end of the shaft thus causing the spindle to advance until



Self-locking Tailstock Mechanism.

stopped by clamping the article between the centers. This movement of the handle may be from forty to sixty degrees. Upon the stopping of the revolution of the shaft, further movement of the handle, under somewhat increased pressure, forces disk *B* along the shaft as the steel pins ride out of the slots upon the plane areas provided. As the pins slide upon these areas the projecting hubs on the disk and nut come together which causes the shaft to draw the gear firmly against the friction washer and bearing, thereby locking the whole. This portion of the operation requires the handle to be moved through an angle of about forty-five degrees. Should the han-

dle continue to be moved the steel pins will come against the little shoulders at the end of the plane areas which they cannot over-ride. Thus, the article is caught and fastened on the centers by one movement of the handle. To release the article the handle is moved in a reverse direction revolving disk *A*. Disk *B* would tend to follow in its locked position, but the shaft is held by the greater friction of the double cone washer and the gear. Therefore, disk *B* remains stationary as the two steel pins slide back into the deeper portion of the slots in disk *B*, which then springs forward bringing the two disks together, thus relieving the friction of the gear. Further movement of the handle revolves the mechanism bodily, drawing back the spindle.

A lathe equipped with this device has been in continuous daily use for the last two years and has required but one adjustment for wear. STEPHEN E. WOODBURY.

Cambridge, Mass.

CUTTING A GEAR IN A LATHE.

Figs. 1, 2 and 3 show a method of cutting gear teeth in the lathe which may be found useful where there are but one or two to be cut and it does not seem advisable to go to the expense of buying a cutter. As shown, the blank *D* is mounted on an arbor, and the tail of the dog which carries it is blocked in the faceplate slot by the wooden wedge *F*. The gear which was being cut in this case was to have 120 teeth. Since the back gear ratio was 12 to 1 the flange of the cone pulley was used as a dividing head with the back gears thrown in. The flange was stepped of into 10 spaces with the dividers. Since the pulley makes 10 revolutions to one of the work this gave the required 120 steps for cutting the teeth.

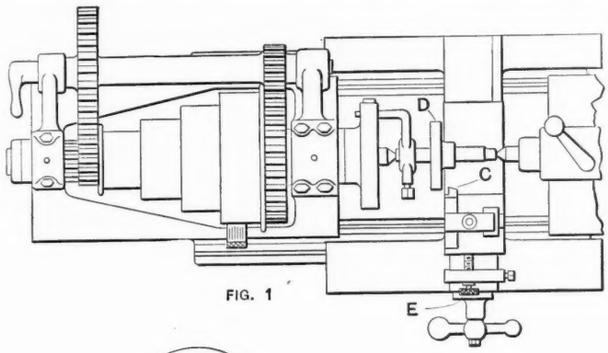


FIG. 1

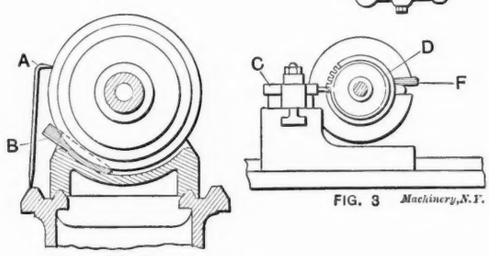


FIG. 3 *Machinery, N.Y.*

FIG. 2

Method of Cutting Gears in Lathe.

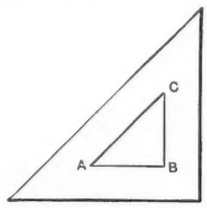
Wooden wedge *B* was driven in between the cone pulley and the head stock, just tight enough so that the cone pulley could be moved by hand without great difficulty. A scratch awl *A*, with one end bent at right angles and sharpened at both ends, was used to locate the divisions. One end of the awl was set in a prick punch mark on top of the front carriage *V*, and the scribed graduations on the pulley flange were brought around to the upper point of the awl one after the other, thus moving the blank into proper position for cutting the successive teeth.

A lathe tool was ground to the proper shape, blocked up to the center line of the lathe, and clamped in the tool post on its side. In cutting the teeth the regular screw cutting stop *E* was used to regulate the depth. The carriage was run back by hand, the tool fed in a little way, then the carriage was run forward, thus taking a planing chip out of the tooth space. The carriage was again run back, the tool fed in and run forward again, taking in this way successive chips until the proper depth had been reached as determined by the stop, when the blank was indexed as previously described and the operation repeated for the next tooth. If the lathe used has no stop such as is used for thread cutting, a block may be clamped on the cross slide way at the rear of the tool post to limit its inward movement. This will insure an even depth for all the teeth. JAMES MCCARTHY.

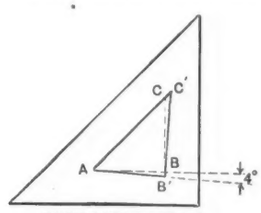
TRIANGLE FOR DRAWING THREADS.

Most draftsmen have more or less trouble in drawing the common representation of small screw threads. The accompanying illustrations show a simple device which makes this operation much easier, quicker and not so tiresome. The threads also can be made more uniform. Any draftsman can make this tool himself.

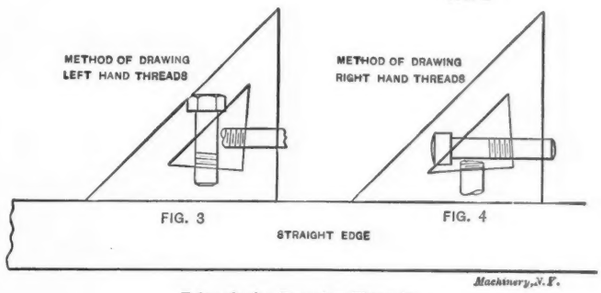
Take an ordinary celluloid triangle, as shown in Fig. 1; a 45-degree triangle is preferable as the opening, *A B C*, in the



ORDINARY TRIANGLE
FIG. 1



TRIANGLE WITH DEVICE FOR DRAWING SCREW THREADS
FIG. 2



Triangle for Drawing Threads.

center is larger, but a 60-degree triangle can be used. First make lines on the triangle as represented by the lines *A B'* and *B'C'* in Fig. 2. These lines can be scribed on with any sharp instrument and should be at an angle of about 4 degrees with the horizontal. Now take a sharp knife and cut away the celluloid very carefully till you have almost cut down to the lines. Then take a fine file and finish off to the lines, making the edges smooth and straight. When completed you will find that you have a very handy triangle. Either horizontal or vertical threads may be drawn without changing the position of the triangle, and right or left-hand threads are drawn by simply turning it over. J. W. COLEMAN.

Bridgeport, Conn.

TIME SAVING IN THE DRAFTING ROOM.

It frequently happens that the drafting room in a large plant gets behind in its work, and the shops commence to shout for drawings. It is not always advisable to send out pencil drawings, because, if there is to be any record kept of the work done in the drawing room, a copy of each drawing should be made before sending it out. Besides that, pencil drawings get mighty greasy and torn knocking around the shop or field. This not only makes it difficult for the workman to understand, but when it is finally returned to the drawing room, tracing it satisfactorily is all but impossible.

A quick and sure way to solve this problem is to trace the sheet upon tracing paper with a soft pencil. By making the drawing on the tracing paper, not only time but material is saved. This can be done in about one-third the time in which the drawing could be traced upon cloth. Care should be taken, however, to make the lines heavy, so that it will print well, and in passing it is well to state that curves and circles can be inked in more quickly and greater satisfaction be given than if they be put in pencil. If strips of drawing paper be pasted on the edges of the paper, it will not tear.

Another scheme for sending out copies of small or detail work is to have a cross section sketch book about seven and one-half inches by ten and one-half inches. Next to each cross section page should be a number of thin blank pages, preferably three. After the sketch has been drawn in lightly, carbon paper can be inserted between the sheets and the sketch gone over with a glass point or hard pencil. Then these carbon copies can be torn out and sent to the shops, the cross section page being kept for record. These books are handy alike for reference and filing. F. R. STEUART.

Sparrows Point, Md.

CASTING OUT THE "NINES" TO PROVE MULTIPLICATION AND ADDITION.

Frequently it is desired to prove a problem in multiplication, especially where the numbers are large and the final result of the problem depends entirely upon accuracy in the first multiplication. A short cut or simple method of doing this is by casting out the nines, and thus proving the product to be correct. Example as follows:

31416 —6 } 6 × 6 = 36; dividing by 9 remainder
7854 —6 } equals 0.

125664
157080
251328
219912

246741264 —0

In the multiplicand, after casting out nines (3 + 1 + 4 + 1 = 9) we have a remainder of 6, also in the multiplier after casting out nines in the same manner we have a remainder of 6, multiplying the sixes together (6 times 6 equals 36) and dividing by nine we find a remainder of 0, therefore if the multiplication is correct after casting nines from the product in the same way as from the multiplier and multiplicand, we will have a remainder of 0.

Addition may also be checked by this method, by adding the remainders and casting out nines instead of multiplying them and dividing by nines; the nines are to be cast out of the sum the same as in the product.

Meadville, Pa. E. W. BOWEN.

A COMBINATION DRILL JIG WITH MOVABLE LEAVES.

Fig. 4 represents a piece of work in which there are two holes in one end; one hole is straight, and the other is tapered, being drilled and taper reamed. It was first decided to make three jigs and make three separate operations, because the holes come so close to each other that it would be impossible to place all three bushings in one leaf of the jig. But as an alternative I suggested a jig as shown in drawing which has three leaves; it was made and gives perfect satisfaction. In using it the operations are as follows:

The work, *A*, is placed in the jig as shown in the three views and is fastened by means of a slide clamp and lever, *B*. The leaf *C* is then closed down into position and a 1/32-inch hole is drilled the full depth that the reamer is to enter. Leaf *C* is then opened and leaf *D* is closed, and reamer is used; and so on with leaf *E*, which completes the operations. L. J. G.

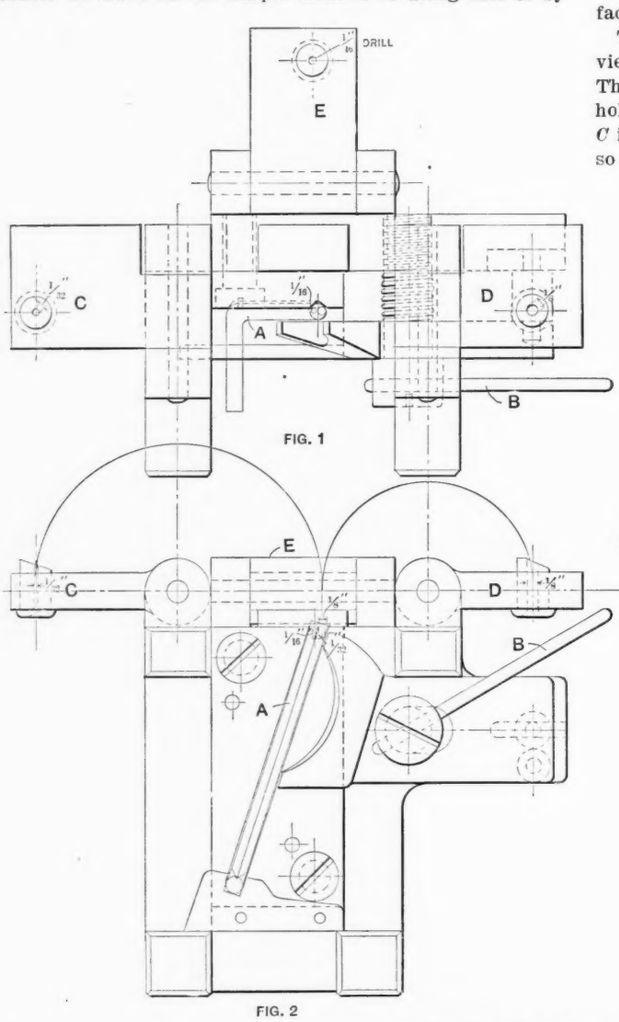


FIG. 1

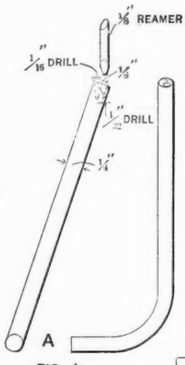


FIG. 4

FIG. 2

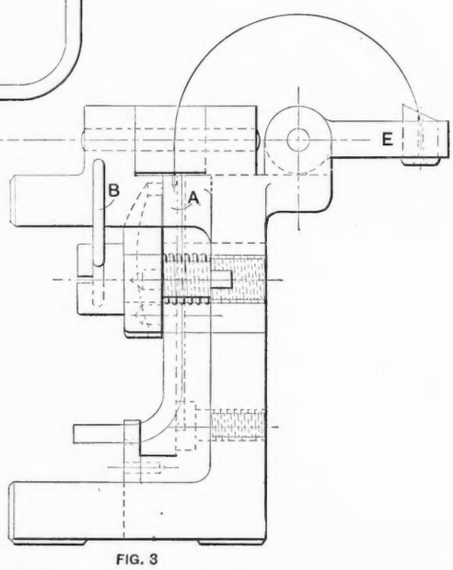


FIG. 3

A Combination Drill Jig for an Unusual Operation.

SOME TRACING METHODS.

There are some things that a beginner in a drafting room should be told before commencing to trace.

First, he should be taught how to tack the tracing cloth to the board. I have found from years of experience that the greatest satisfaction with the smallest amount of labor and thumb tacks is given by putting in the tacks as shown in the accompanying diagram. This applies, of course, when one has a large tracing to make. In the case of a small tracing, one tack in each corner will suffice.

It is immaterial which side of the cloth is used to trace upon. The advantages of the smooth or glossy side are that ink can be more easily erased, that it does not collect so much dust, and that the finished tracing looks better than when the dull side is used. But, when the glossy side is used the edges curl

up, unless the tracing cloth be re-rolled, which the majority of chief draftsmen will not permit; chalk, soapstone or some one of the many preparations made for this purpose, must be thoroughly rubbed in before ink can be used, and if, as in the case where the tracer also makes blue-prints, the cloth remains tacked down for a number of days and is worked upon only at infrequent intervals, this must be done not once, but a number of times. When chalk or anything else is used always be sure to either wipe it off with a clean cloth or brush it from the cloth thoroughly.

in a few minutes, it is always best to wipe it out. A clean linen cloth should be kept for this purpose. F. R. STEUART.

Sparrow's Point, Md.

METHOD OF ENLARGING OR REDUCING DRAWINGS.

Very often it is desired to reduce or enlarge drawings, scroll designs, letters, maps, etc. This can be done to scale or by proportional dividers but perhaps the simplest and quickest method is as shown in Fig. 1.

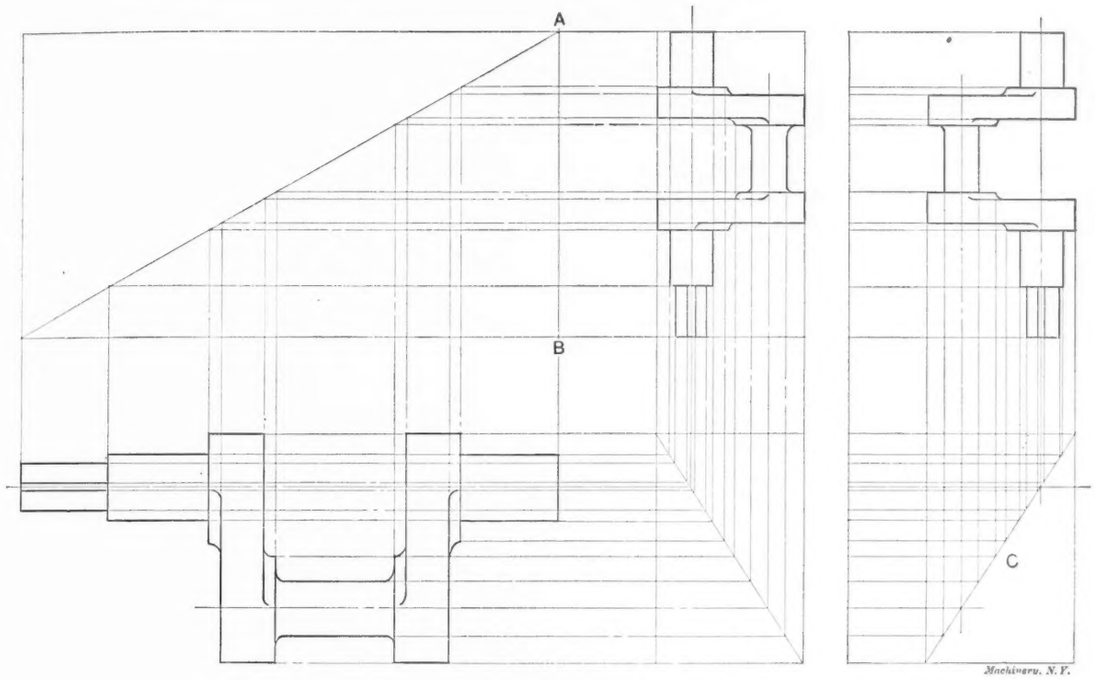
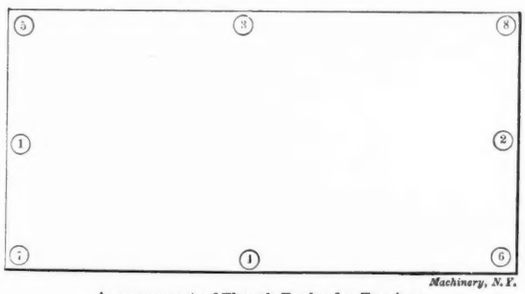


Fig. 1. A Method of Reducing the Scale of a Drawing.

Fig. 2. Changing from Right to Left Hand.

The next thing to do is to draw the border and trimming lines. The latter should be drawn in lightly, so that when the tracing is finished and trimmed it will present a neat appearance.

Under ordinary conditions it is always best to start in the upper right-hand corner of the sheet and finish the upper part



Arrangement of Thumb Tacks for Tracing.

of the sheet first. This insures the tracing being kept clean. Apropos of cleaning, I have found that the best rubber for cleaning is the bread rubber. It wears out very quickly, however.

When tracing an arrangement or a complicated detail, it is always best to trace in the top part first. For instance, there is a vertical steam cylinder to be traced; start on the plan and trace the gland first, because everything else will come under it. Then dot in the stuffing box, cylinder head, etc.

Always draw in the center lines first, then the outlines, dimension lines, dimensions and, last of all, crosshatch.

Keep all triangles, scales, protractors, etc., as clean as possible. Wash them weekly with some good soap and cold water. Do not use sandsoap or anything that will scratch them.

It is false economy to keep ink in ruling pens or other inking instruments. When through using an instrument for the time being, even if one is sure that he will pick it up again

The only dimension necessary to lay off is the distance shown at *A B* which of course is the dimension desired for the reduced or enlarged copy. Fig. 1 shows the method for reducing which also applies for enlarging. It will be noticed that large and small rectangles are drawn with a diagonal line through each, and to these lines points are projected, and from there to the space where the copy is desired. The intersection of these lines are points of the copy.

Fig. 2 shows line *C* reversed from that shown in Fig. 1 which causes the copy to become reversed. This is especially convenient where it is desired to obtain a right and left of any object. In making the third view of an object when detailing it is more convenient to plot it as shown in Fig. 3 than by the usual method of scaling each dimension as it can be done much quicker and with less chance of error. The diagonal line should of course be at 45 degrees in this case. In actual use, dashes cutting the diagonals are sufficient, instead of the construction lines shown in the above cuts. WINAMAC.

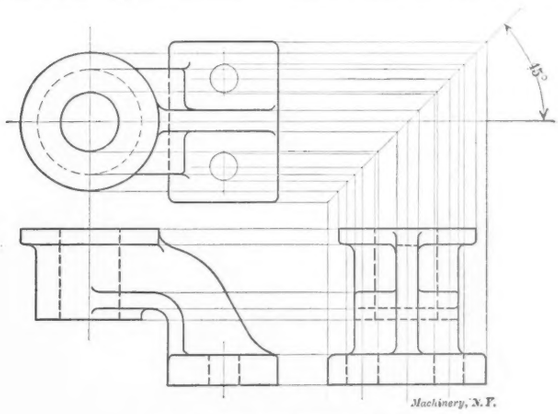


Fig. 3. Projecting the Third View.

SOME DOGS AND DRIVERS.

The dogs and drivers illustrated and described in this article will probably not be new to all the readers of MACHINERY as they are old, tried and true friends in the shops where they are being used, but may perchance fill a long-felt want for somebody on the lookout for something of this kind.

Fig. 1 shows a style of dog used extensively in the grinding department on small work, say ⅛ to ⅜ inch diameter and highly finished, where it is necessary that the work be

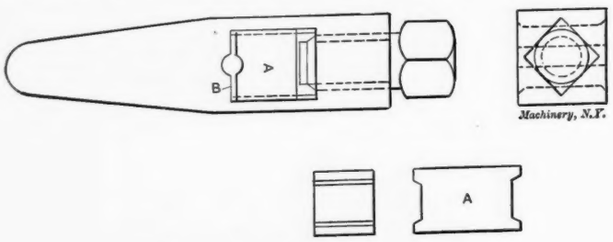


Fig. 1. A Dog for Grinding Small Work.

gripped tightly but without marring the finish. Two grades of these are used; one grade for the lathe work, being a finished forging with hole carefully forged in and having no finish afterwards except filing the edges and corners rounding. The other grade is not so carefully forged and is finished all over, including the hole. The construction can readily be seen from the sketch. The jaw *A* is shown sepa-

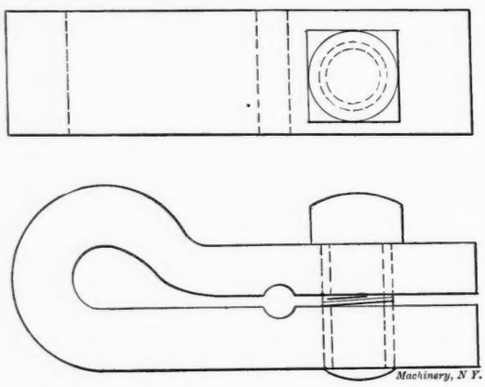


Fig. 2. A Dog for Grinding at Low Speeds.

rately in the lower view, Fig. 1, before being staked in. After the jaw is staked in it is tapped lightly with a hammer until it will slide easily on the beveled edges of the slot. A piece of sheet steel 1/16 inch thick is put in between the jaw and the dog at *B* and the jaw is tightened down on it by the screw. The piece of sheet steel is then center punched for the hole. The holes are drilled and

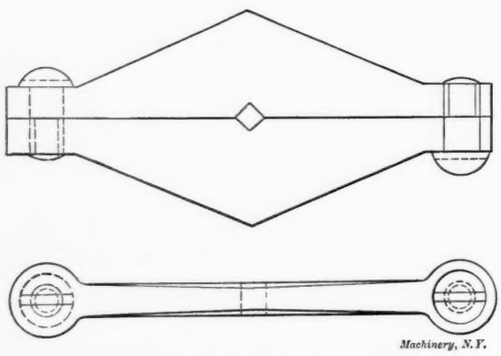


Fig. 3. For Light Grinding on Tool Work.

reamed in a four-jaw independent chuck. After drilling and reaming they are carefully balanced so that at 1,000 revolutions per minute there will not be the slightest flutter in the work being driven. The dog is made of tool steel, the jaw of soft steel and the screw of tool steel, hardened.

Fig. 2 shows another type of driver used on a coarser grade of work which does not run at as high speed and consequently does not have to be so carefully balanced. Hence it has no finish; just a forging tapped, drilled and reamed.

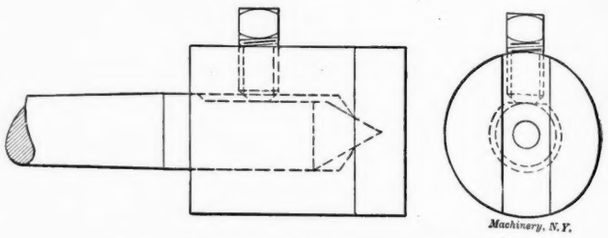


Fig. 4. For Driving Thumb-screws in the Lathe.

Fig. 3 shows a driver used on the universal grinders for tool work which is very handy for light grinding. It is made of tool steel finished all over, and with three sets of screws it will hold pieces of any shape and size within its capacity.

Fig. 4 is a driver for the lathe which was made when some thumb screws were to be turned and threaded. The idea proved so good that it has been extended so that there

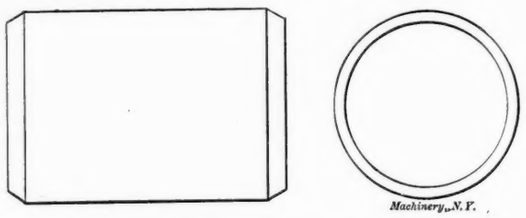


Fig. 5. A Difficult Piece to Handle in the Grinder.

is a set of drivers for all shapes and sizes. The chief advantage of this idea is that with one center for each lathe, turned to one inch in diameter, the drivers will interchange with all the lathes. A pointed center is made about ½ inch longer than the usual center and flattened for the screw used with the drivers. The drivers are of cast iron and one can be made in about half an hour, as there is no finish necessary.

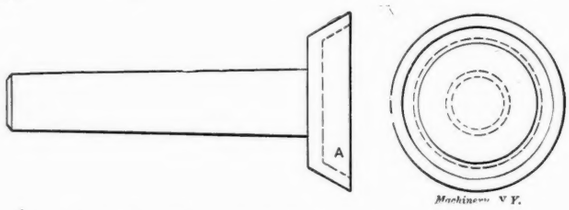


Fig. 6. Head Center for Driving Piece shown in Fig. 5.

Fig. 5 shows a hardened tool steel roll 2 inches diameter by 3 inches long, of which we grind quite a number. This roll can have no center holes, so some sort of friction driver is needed, and Figs. 6 and 7 show the driver and center for the grinder.

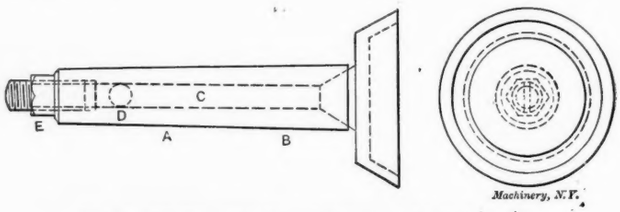


Fig. 7. Tail Center for Supporting Piece shown in Fig. 5.

Fig. 6 is the headstock driver hardened on the driving end and ground on the inside at *A* to fit the beveled ends of work. Fig. 7 is the tailstock center. *A* is a taper sleeve fitting the center hole in the tailstock spindle, and is hardened on outer end as far back as *B*. *C* is the revolving center, made a running fit in the ¼ inch hole. *D* is a ¼ inch tool steel ball and *E* is an adjusting screw and check nut. When in use the screw is adjusted so that when *C* is bearing against the

ball the tapers are lightly touching. This center is used on a universal grinder with a spring tailstock spindle.

Fig. 8 is a friction driver used in the centering machine for centering shafts from ⅜ to ⅞ inch in diameter and from 2 to 4 feet long. It is made of tool steel, hardened.

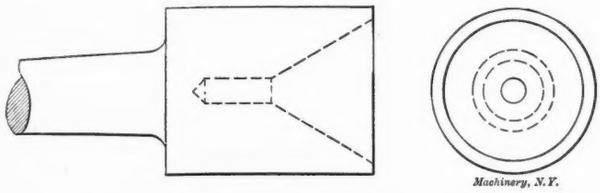


Fig. 8. A Friction Driver for the Centering Machine.

Fig. 9 is a driver for the shafting lathe when filing and polishing shafting; it is made of tool steel.

A square 60 degree center can be used to advantage for light grinding. We have a number of taper pins to grind 4 inches long, 7/16 inch diameter, on the large end and 5/16 on small, and we found the best way to grind these was to

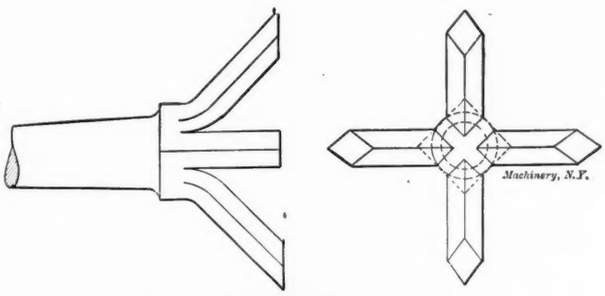


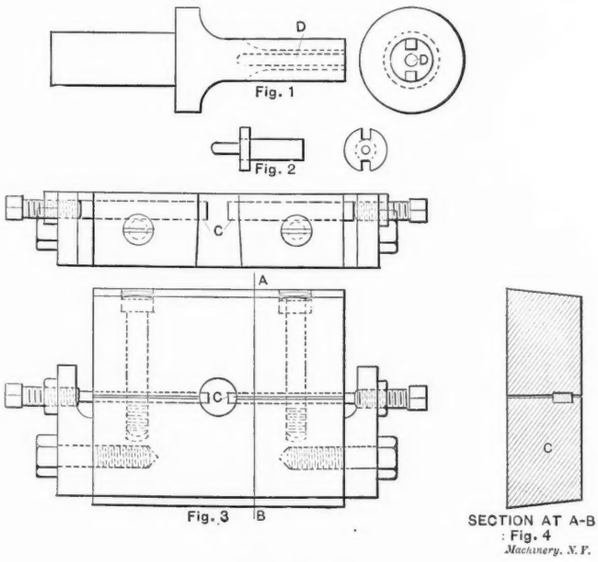
Fig. 9. A Driver for Polishing Shafting.

use a square center finish ground in the machine on the sides of the square so that the corners will run true. This center is of course used with a spring tailstock spindle.

Lowell, Mass. PAUL W. ABBOTT.

A BROACHING DIE.

The accompanying cuts illustrate a form of die that I have never seen published in MACHINERY, although the principle is adaptable to numerous blanking dies that are both difficult



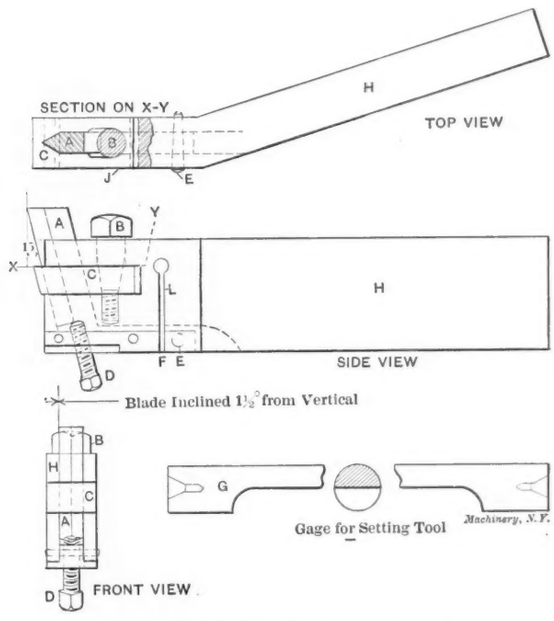
A Die for Broaching.

and expensive to make solid. The cuts illustrate the principle of construction clearly enough so a brief description will be sufficient. The part to be broached, Fig. 2, is made from brass rods in the screw machine, and the die was made to cut the two slots or keyways in the flange. The large end of the stud is set into the die (or punch in this case), Fig. 3, and rests upon the two projecting blades or cutters, *C*. This position of the stud brings the flange within the recess, which centers it. As the punch (or die in this case), Fig. 1, descends the small end of the stud enters the hole, *D*, in the center of the die which serves to keep it straight during the cutting operation. The die descends far enough to carry the flange of the stud past the end of the cutters *C* so it will drop through or be stripped when the die ascends. As indicated in the cuts, the cutters are provided with adjustment so that they may be ground when dull. T. J.

COMBINATION THREADING TOOL.

The cut shows a combination spring and solid threading tool which I found to be the best I ever used, especially for working on tool steel. Here are some of its good points. First it is made high enough so as to go on the carriage instead of on the rocker of the tool post. Therefore the tool is always parallel. Second, the cutters are easily and quickly made and may be quickly changed in the holder from "V" to U. S. S. thread. I have made as many as six in an hour. Third, the blades may be easily set, by bringing the face of the holder at *J* parallel to the face plate and raising the cutter to the center line with the set screw *D*. The gage shown at *G*, which consists of a smooth piece of round stock centered at the ends and milled out to the center line for a short distance, furnishes a convenient means for locating the top of the cutter at the proper height.

The construction of the tool will be readily understood. A slot is milled out on the front end of holder *H* at an angle of



A Convertible Spring or Solid Threading Tool.

15 degrees, to receive the blade *A*. This slot, as shown in the front view, also has an inclination of 1½ degree from the vertical to make the cutter agree with the average inclination of the thread in a U. S. standard screw. In a horizontal slot in the end of the holder is fitted the clamping yoke *C*. The top view shows this piece quite plainly. It has an opening in it through which the blade *A* passes, and is provided with a tapering seat for the tightening screw *B*. As this is screwed down, yoke *C* is drawn in and the blade *A* is held firmly back against its seat; screw *D* adjusts the blade for height. A saw cut at *F* extends nearly through the holder thus leaving the upper end flexible to give it the effect of the well-known gooseneck tool. Through a slot in the bottom is passed the tie piece *F* which is pinned fast to the outer division of the holder and may be, if so desired, connected with the shank by the taper pin *E*. This allows the tool to be used either as a solid or as a spring tool holder. EVERETT KNEEN.

Kearny, N. J.

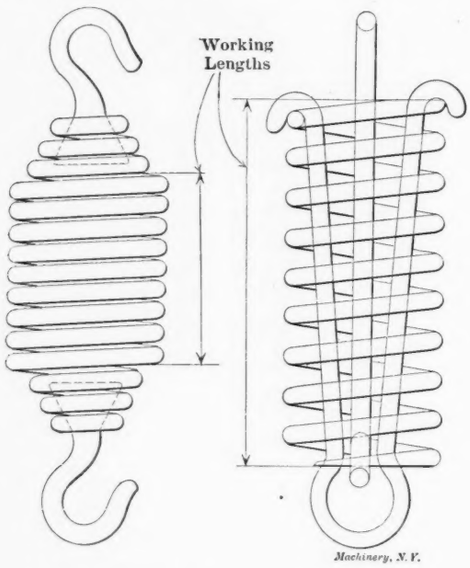
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

TO INCREASE THE WORKING LENGTH OF COIL SPRINGS

The sketch shows two springs, one as usually constructed and one which is not commonly used but which has a number of advantages over the former. It will be noticed in one that a hook with a conical end is inserted in each end of the spring, and the coils are then pinched around it. This not only requires special hooks but necessitates forming the ends of the

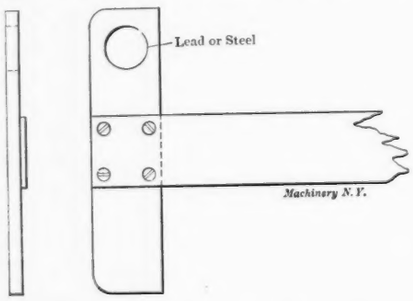


spring which in itself is no easy job, especially when the larger sizes of wire are used. Another disadvantage is that where only a limited space can be had for the spring a good share of it is taken up by the ends and no benefit derived therefrom. The object of the improved manner of using a spring is to use it under compression instead of under tension, as this is preferred when it can be done. Two U-shaped pieces are formed and inserted in the spring, which allows the full length to be used.

WINAMAC.

WEIGHTED T-SQUARE HEAD.

The accompanying cut shows a T-square which I have used for some time with good results. A 1½-inch hole is bored in the upper part of the head and a piece of steel is inserted.



The upper part of the head being the heaviest, it always tends to keep the upper edge of blade down close to the board.

GORDON F. MONAHAN.

Bridgeport, Conn.

METHOD OF DIVIDING FRACTIONS BY TWO.

Perhaps the readers of MACHINERY will be interested in the way I divide fractions by 2. I refer to a table of decimal equivalents and find the fraction which is to be halved, as, for example, 11/64; instead of dividing by 2, multiply by 5, giving as a result 55/64. Now, opposite 55/64 will be found the decimal equivalent 0.859375. Point off another decimal place, as there must be one more decimal place in the result than in the decimal equivalent, for the decimal equivalent is, of course, ten times too large. Hence, the answer is 0.0859375. To halve a mixed number by this method, as, for example, 17 9/32, multiply both the whole number and the fraction by 5, pointing off one place as before, in each case. $17 \times 5 = 85$; $9\text{-}32 \times 5 = 45\text{-}32 = 1\ 13\text{-}32 = 1.40625$. $8.5 + 0.140625 = 8.640625$. By this method any fraction can be halved and the results read direct from the table with little liability of error. I find it very convenient when laying out dimensions each side of a center line or finding the radius of a circle, especially when the dimensions include 64ths, as, for example, 11 19/64.

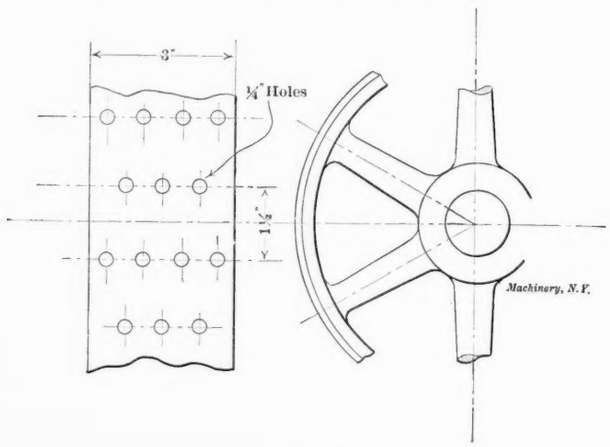
Another good method is to use the February data sheet, in which the values of fractions are expressed in 64ths, as, for example, 13 7/16 = 860/64, which divided by 2 = 430/64, and by referring to the data sheet table, the equivalent is found to be 6 23/32.

LOUIS F. LANG.

Boston, Mass.

TO PREVENT THE SQUEAKING OF LOOSE PULLEY BELTS.

If there is one thing annoying in the machine shop that should be avoided it is the constant squeaking of the tight

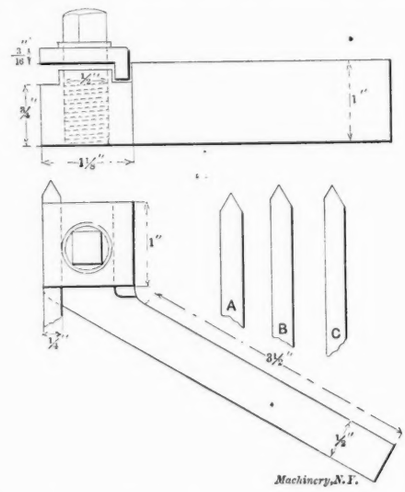


pulley on the planer and emery wheel while the belt is being shifted. This can be prevented by drilling a series of holes in the rim as here shown.

WINAMAC.

THREADING TOOL HOLDER FOR HIGH-SPEED STEEL.

The cut shows a toolholder which I devised for the economical use of high-speed steel in thread cutting. One advantage of the holder is that cutters can be broken off from the bar



and used without further working. By grinding the cutters as indicated at *A*, *B* and *C* a variety of pitches can be cut close up to the shoulder.

STEPHEN COURTER.

Paterson, N. J.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page will be used for the publication of shop receipts which the contributors know from experience to be practicable. Nearly all readers of MACHINERY can add something, and it is desired that they use this page as a medium for exchanging useful formulas. It makes no difference if they are old and supposedly well-known, provided they have not already appeared in this department.

214. TO WRITE ON CELLULOID.

To write on triangles or other instruments made of celluloid use anhydrous acetic acid. The writing will appear dull on the shining surface. If colored writing is desired add some coloring matter to the acid. J. M. MENEGUS.

Los Angeles, Cal.

215. IRON OR STEEL?

To find out whether a piece is steel or iron touch it with nitric acid, using a stick of wood, and then wash it with water. If iron, a light or azure stain will appear; if steel, the stain will be black. J. M. MENEGUS.

Los Angeles, Cal.

216. VARNISH FOR IRON WORK.

To make a varnish for outdoor wood and ironwork, dissolve in about 2 pounds of tar oil ½ pound of asphaltum and a like quantity of pounded rosin; mix hot in an iron kettle, care being taken to prevent any contact with the flame. When cold the varnish is ready for use. JOSEPH M. STABEL.

Rochester, N. Y.

217. ALUMINUM SOLDER.

To make a solder for soldering aluminum, melt together 1 pound block tin, 4 ounces spelter, 2 ounces pure lead and 3 pounds phosphor tin. When using, clean the work with benzine and apply with a heated copper bit in the usual manner. L. C. CARR.

Lynn, Mass.

218. CEMENT FOR ATTACHING METAL TO GLASS.

To make a cement for attaching metal to glass mix 2 ounces thick glue, 1 ounce linseed oil, ½ ounce turpentine. Boil together for a short time when it will be fit for use. Apply hot with a brush and clamp the parts together for about two days to allow the cement to dry. R. M. K.

219. LUBRICATING MIXTURE FOR CUTTING THREAD IN TOOL STEEL.

To make a good lubricating mixture for cutting thread in hard tool steel, use equal parts of turpentine and benzine or kerosene. For cutting in soft tool steel mix equal parts of kerosene and lard oil. These mixtures always flow even and keep just about enough moisture at the cutting point.

Kearney, N. J. EVERETT KNEEN.

220. CLEANING SOLUTION FOR BRASS.

To make a cleaning solution for brass work mix 1½ ounce nitric acid, 1 drachm saltpeter, 2 ounces rain water. Let the mixture stand a few hours and then the articles to be cleaned may be dipped in quickly and then rinsed off and dried. R. M. K.

221. TO BRAZE STEEL AND IRON WITHOUT HEAT.

To braze steel or iron without heat take ¼ ounce fluoric acid, 2 ounces of brass filings, and 1 ounce of steel filings. Put them all into the fluoric. Touch each part of the work with the mixture, and put them together. Take care that the fluoric acid is put into an earthen vessel.

Rochester, N. Y. JOSEPH M. STABEL.

222. GLYCERINE-LITHARGE CEMENT.

A handy cement to have in the shop for stopping leaks, etc., and which can be used for cementing glass, brass, etc., is made by mixing equal parts of litharge, commercial glycerine and Portland cement. This cement will harden under water and will withstand hydrocarbon vapors. O. E. VORIS.

Dayton, Ohio.

223. BICYCLE TIRE ANTI-LEAK.

Many machinists ride their bicycles to and from work and are consequently interested in anything that will make tires more nearly puncture-proof. I have not tried the following anti-leak compound, but infer from a note in the *English Mechanic* that it works successfully on both single and inner-tube tires. Mix ¼ pint of silicate of soda (water glass), ¼ pint of commercial glycerine and a large tablespoonful of rubberine; inject about a teacupful into the tire. If too thick, a little water can be mixed with it to thin it. If rubberine is not available use powdered rosin. M. E. CANEK.

224. TO PUNCH HARD RUBBER.

To punch hard rubber successfully heat the punch and die, or the material. The blanks usually curl or wrinkle into almost every conceivable shape in the operation of cutting. To straighten and bring them back to their original outline, allow the punchings to drop into a pan of hot water. The action of the hot water causes the curled parts to return to their former flat position the same as before passing through the die. L. C. CARR.

Lynn, Mass.

225. TO MAKE VANDYKE PRINTS MORE TRANSPARENT.

To a pint of best grade gasoline, add as much paraffine as the gasoline will readily dissolve and spread this solution evenly over the print with a soft brush, wipe dry with a piece of white cotton rag and print in the usual manner. Vandyke prints treated in this way will require only about two-thirds the usual time to print. E. W. BOWEN.

Meadville, Pa.

[A sample Vandyke "negative" partially treated in this manner shows a marked increase in transparency; a blueprint made from it is overprinted on the treated side and under exposed on the other.—EDITOR.]

226. TO PLATE POROUS WORK.

In the plating of brass or cast iron, or other porous metals there is more or less trouble with what is called "spotting out" which is caused by the cyanide getting into the pores, and it has been hard to find a satisfactory remedy for this trouble. The following can be used with good results: First, give the work a good stiff coat of nickel, then put it through a brass solution without buffing. After the required deposit has been obtained, rinse it in cold water, and then hang in boiling water, as long as possible without tarnishing. Then hang it in a good hot oven until thoroughly dried out, after which buff and hang for a few moments in gasoline, and put it in the oven again. You will find this will cure a great deal of the trouble experienced on that class of work. This is a valuble process and one never before printed.

Bridgeport, Conn. J. L. LUCAS.

227. FOR COLORING BRASS BLUE BLACK.

To color brass blue black make a solution of ammonia and copper carbonate in the approximate proportion of 10 parts of ammonia and one part of copper carbonate by weight. Shake the mixture well until the copper carbonate is dissolved, adding the copper carbonate to the ammonia little by little until the ammonia will not dissolve any more; then add a volume of clear water equal to about one-fourth of the mixture. The pieces of brass to be colored should be polished bright, either with fine dry emery cloth, taking care not to touch the polished surface with the fingers, or made clean and bright by dipping in a strong solution of caustic soda. Before dipping agitate the compound thoroughly and then immerse the pieces of brass, keeping them in motion two or three minutes, rinse off in clean water, and dry in sawdust or clean cotton waste. When not in use the solution should be kept in a tightly-corked bottle. I have used it on instrument work very successfully. H. M. WEBER.

Cambridge, Mass.

* * *

A number of accidents which have occurred recently to British fishing vessels have been attributed to the magnetized condition of the sheath-knives carried by the sailors deflecting the compass needle, says the *Electrical Review*.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

21. B. C. W.—The question arose in our tool department as to the proper size to drill a tap hole for a 14—24 tap. The following handbooks and tables were referred to with the following results:

Saunders' Handbook .....Drill No. 7
Morse Twist Drill Co.....Drill No. 9
Starrett's Gage Chart.....Drill No. 6
Murdock's Table .....Drill No. 4
Standard Drill Co.....Drill No. 10
Machinery Data Sheet (V-thread)....Drill No. 8

Will you kindly inform us through your valued column, or otherwise, why there is so much difference?

A. It will be seen that the various sizes given, range between No. 4 and No. 10. This variation, however, is not so great as it sounds. A No. 4 drill is 0.209 inch in diameter, while a No. 10 has a diameter of 0.1935 inch, a difference of only 0.0155 inch, which is no more than enough to cover varying conditions for a tap of this size. For a theoretically full sharp V-thread the proper amount to subtract from the outside diameter of the tap to give the diameter of the tap drill can be found by dividing 1.732 by the pitch. This will give us in this case, $1.732 \div 24 = 0.0721$ inch. Subtracting this from the outside diameter of the tap, we have $0.2421 - 0.0721 = 0.170$, which is practically the diameter of a No. 18 drill. This, however, would not be at all a practical size to use. The action of a small tap varies with its condition as to sharpness and hardness, and the material in which it is used. A sharp new tap in good cast iron will cut quite a clean chip, so a tap drill nearly as small as a No. 18 might, perhaps, be used, although it would quite likely give so sharp a thread as not to admit the more or less imperfect commercial machine screw, and it would also probably take so much force in tapping the hole as to make it difficult to keep from breaking it. In steel, on the other hand, even with a new tap, but to a much greater degree with one slightly worn, the action is only in part that of cutting; the thread is to a large extent formed by pressing the metal into shape. For this reason the drill needs to be quite a little larger than that theoretically called for, since much less metal is removed than in the previous case. The duller the tap and the softer the metals the more noticeable is this action, until in the case of some grades of brass the tap may do almost no cutting, the thread being formed by pressing the metal into shape. For this, a drill about half way in size between the outside diameter of the screw and the tap drill, as theoretically determined, should be used. This, it will be seen, gives as great a variation as that called for by the various tables our correspondent consulted.

The Brown & Sharpe Mfg. Co. in their automatic screw machine work make regular use of the following table in determining the sizes of tap drills. The results given by this table require a somewhat larger drill than would be necessary for hand work, since here there is less danger of breaking the tap than there is in the machine. If the tap is going hard the workman can remove it, clean, oil, and start in again, the cleaning process being repeated as often as may be needed to screw the tap safely to the bottom of the hole. The table and the accompanying directions are copied from their treatise on the automatic screw machine.

TABLE FOR USE IN SELECTING TAP DRILLS.

Threads per inch.	Theoretically Full Thread. Double Depth = $\frac{1.732}{P}$	Amount to be subtracted from Outside Diameter of Tap for Tap Drill Size.
74	.0234	.009
72	.0240	.009
70	.0247	.010
68	.0254	.010
66	.0262	.010
64	.0270	.011
62	.0278	.011
60	.0288	.012
58	.0299	.013
56	.0309	.014
54	.0320	.014
52	.0333	.015
50	.0346	.016
48	.0361	.017
46	.0376	.022
44	.0393	.023
42	.0412	.025
40	.0433	.026
38	.0456	.027
36	.0481	.029
34	.0510	.030
32	.0540	.032
30	.0577	.035
28	.0619	.037
26	.0665	.044
24	.0720	.048
22	.0786	.052
20	.0865	.057
18	.0961	.064
16	.1080	.072
14	.1238	.082

"The sizes for tap drills given in the above table are from 4-10 to 66-100 of a full thread; the former amount being allowed on fine threads, as these are usually for small screws. These sizes are only approximate, and often even larger drills could be used and the work be as good as is required for the purpose for which it is to be used. In other cases the thread must be nearer full and then it is usually desirable to use two taps, thus dividing the work. Machine screw taps to fit the usual commercial screws are usually from 0.008 to 0.016 inch larger than the size usually given in tables for the diameters of machine screws, and the amount given in the table above should be subtracted from the actual size of the tap as measured by the micrometer. For example: The size of a No. 12 screw is usually given as 0.2158 inch diameter, but the taps will measure from 0.219 inch to 0.224 inch. Then, taking the average, 0.222 inch, and deducting .048 inch, the amount given in the table for 24 threads, the result, 0.174 inch for the tap drill, gives as full a thread as is usually practicable for use in an automatic screw machine; and many times even larger tap drills are used."

It will be seen from the above that on these small taps, especially, the question of sizes of tap drills is one that varies with the condition of the tap, the nature of the material to be worked, and the way in which tapping is done, whether by hand or machine. It will be noticed that the size as given in the data sheet is about the average of the various sizes given, so it may be taken as representing good average practice, which is, however, to be varied to suit the special conditions of the work in hand.

* * *

A LARGE EDITION.

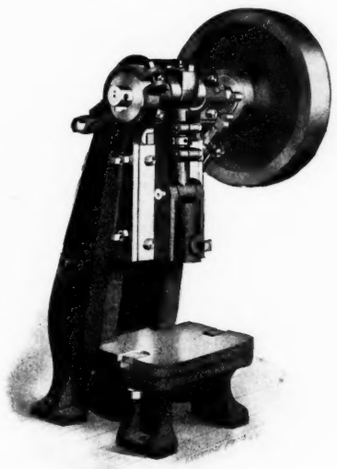
At the time this was written the New York Telephone Company began the work of delivering the new summer telephone books for New York and vicinity, and collecting the old ones. The edition filled 25 freight cars and weighed 400 tons. About 200 men are employed for the distribution, which takes about four weeks to complete, and means the handling of about 800 tons of paper, since the old books are taken away when the new ones are left. This is done for the protection and convenience of the subscriber, and to prevent the use of the old directories which would result in the giving of many wrong numbers, and would be, in consequence, a drag on telephone service. The new directory contains the names of over a quarter of a million of business houses and individuals—365,000 books were distributed. Originally the telephone book was used only for the purpose of looking up telephone numbers, but at the present time the list of telephone subscribers in New York city is so complete that the telephone directory has become the best general directory of New York and vicinity, and is almost absolutely accurate since it is revised and a new issue distributed every four months. An advertisement recently issued by the telephone company illustrates graphically the extent to which this feature has grown. It is in the form of a picture showing side by side Mount Everest, the highest mountain in the world, and a tower of 365,000 telephone books, one on top of another, which makes a column 6¾ miles high, towering over a mile above the top of the mountain.

MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

SMALL BLISS PUNCH PRESS.

The press shown below is interesting from its small size and from the fact that it is designed to take the place of the usual foot press in lines of work in which that tool has been extensively used; it is particularly adapted for making such parts as are used in the manufacture of burners, light jewelry, etc., and it may be employed as well for small punching, blanking and forming. The general lines of the press are similar to those of the regular Bliss inclinable style, although some slight changes due to the small size of the machine have been made. The ram adjustment is obtained by a split sleeve



Small Bliss Punch Press.

connection having a right and left-hand thread. The adjustment is made by turning the adjusting screw, which is securely locked by means of the two bolts shown. The press is fitted with the maker's two-piece clutch, which is practically instantaneous in its action. The wheel is bronze bushed, and has a solid web.

The principal dimensions are: Opening in bed, 3 inches in diameter; distance back from center of slide, 3 inches; width of opening in back, 4 inches; distance from bed to slide, ram and adjustment up, 5 inches; length of stroke, 1 inch, although the press can be made with a 2-inch stroke if desired. The balance wheel runs from 150 to 200 revolutions per minute. The bench space required over all is 16 inches x 16 inches. These presses are made in large quantities with suitable jigs and gages, so that the parts are interchangeable, and low priced as well, thus enabling the press to be put on the market at a very reasonable figure. The E. W. Bliss Co., 5 Adams St., Brooklyn, are the builders.

FINISHING BOX TOOL.

The box tool shown in the accompanying halftone is designed to make available for the ordinary round turret the advantages of the tool with rocking adjustment, so successfully used on flat and hexagon turret lathes. The advantages of the tangent or "over shot" blade are: it is a free and rapid cutter; its controlling cam allows the cutting edge to be cleared from contact with the finished work on the return while the machine is running, thus avoiding marking of the work; and the construction allows the relieving or turning of work to a smaller diameter for any desired distance between two larger diameters. The adjustable back-rest jaws supplied with this type of tool have a burnishing effect that produces a smooth finish. This style of tool can be adjusted for size much more quickly than can the old form of box tool with fixed blade, and is very rigid in its action. The cutting tool can be set to precede or follow the back-rest jaws. It is made by the Garvin Machine Co., Spring and Varick Streets, N. Y. There are several sizes in the line, with a maximum capacity for work 2 inches in diameter with a length of cut of 4 inches.

Garvin Finishing Box Tool.

A CONVENIENT DRAFTING TABLE.

The drafting table shown in two different positions in Figs. 1 and 2 is made by C. E. Hemp, Hamilton, Ohio. The frame or base of the table is made of oak, strongly put together, varnished and finished with a dead gloss. The frame which holds the drawing board is made of white maple. The board

Fig. 1. Drawing Table, with Board Horizontal.

itself is of white pine; it may be fixed at any angle by the use of two handscrews, and is raised or lowered to any height desired by operating the crank on the side. As may be seen the frame is mounted with nickel-plated brass fittings for a parallel ruler which is part of the outfit. This table will be

Fig. 2. Drawing Table Elevated to Angular Position.

furnished with a plain top, if desired, instead of with the drawing board top as illustrated, or quotations will be furnished on other sizes than the standard, which carries a board 21 inches high and 41½ inches long. Extra boards, which are removable, will be furnished at a slight additional cost.

OBITUARY.

Loring Coes, a well-known inventor and manufacturer of Worcester, Mass., died July 13 at the advanced age of ninety-four. He was born in Worcester, April 22, 1812, and had been identified with that community from his birth as carpenter's apprentice, journeyman, and founder of several enterprises which developed into important local industries. He was a remarkable character in many respects, and perhaps, with the exception of Mr. Chas. Haswell, the engineer, was the oldest man actively engaged in business in America. Up to the six months' sickness immediately before his death Mr. Coes had practically never been sick or lost a day by indisposition of any kind. Although an important factor in the knife and shear-blade manufacture and an inventor of improved methods of manufacture, his name in most minds, is indelibly associated with the screw wrench.

As a boy, Loring Coes was apprenticed to a carpenter at the age of fourteen, working thus until twenty-two, and then for two years as a journeyman. Then, in 1836, he and his brother, Aury G. Coes, started in business in Worcester, in the manufacture of woollen mill machinery, in the old plant of Kimball & Fuller. This building was destroyed by fire two years after its purchase by the Coes Brothers, whereupon they went to Springfield, Mass., as patternmakers. It was here that Loring Coes invented the improved screw wrench in

Loring Coes.

1839 and the manufacture was begun in Worcester in 1840. In July, 1853, the shear and knife business of Moses Hardy was purchased, and this was conducted along with the wrench business, both ventures proving successful. In 1869 the brothers separated, each forming a new company, A. G. Coes, in company with his son John taking the shear blade business under the name of A. G. Coes & Co. and Loring Coes taking the machine knife works. The Coes patents having expired, in 1871 Loring Coes built a new large factory for the manufacture of the monkeywrenches which he had invented more than thirty years before. In 1875 A. G. Coes died and his two sons continued his share of the business, making shear blades and wrenches as well, until 1888, when a joint stock company was organized and incorporated to manufacture the inventions of Loring Coes, under the name of the Coes Wrench Co. In 1902 Loring Coes acquired the stock and business of the Coes Wrench Co. and was made president, and this is the company which is now making Coes wrenches in Worcester. The accompanying photograph is one that was published in MACHINERY, April 1902, and was taken when Mr. Coes was ninety years old. He was a remarkably active man at this great age, and for forty-four successive years had taken an annual outing in the woods of Maine, to which relaxation he attributed in large measure his long life and freedom from sickness. In MACHINERY, June, 1902, a reproduction of the original Loring Coes patent (reissued in 1849) was published, which showed that in all essential particulars the wrench is practically unchanged up to the present time. While Mr. Coes has been a great improver in the screw wrench since his original patent was taken out, these improvements have been largely in the details of the handle, always a troublesome part.

Louis Cassier, publisher of *Cassier's Magazine* and the *Electrical Age*, was killed at Salisbury, England, July 1, in a wreck on the London & South Western Railway. Mr. Cassier was born in Boston in 1862, and was in common expression, a "self-made" man. When a boy of about eighteen he became a reporter on the *Boston Transcript* and combined reporting with the getting of advertising for the paper. Along toward the end of the 80's he came to New York and became advertising agent for the American edition of the *London Illustrated News*. *Cassier's Magazine* was started in November, 1891, Mr. Cassier being editor and publisher for about a year and a half, when Mr. Albert Spies assumed the editorial charge of the publication in 1893. The London edition of *Cassier's Magazine* was established in 1894, and in 1903 the Cassier's Magazine Co., which had been incorporated with Mr. Cassier as president, purchased the *Electrical Age*. Subsequently a separate concern was formed, the Electrical Age Co., with Mr. Cassier as president, to publish this journal. He was an associate member of the American Society of Mechanical Engineers, a member of the Republican Club, Automobile Club of America, Camera Club, and the Manufacturer's Club of Philadelphia. His home was at Trumbull, Conn., about three miles from Bridgeport. He was married in 1890 to Miss Agnes Nichols, but had no children.

John Saltar, Jr., president of the Otto Gas Engine Works, Philadelphia, Pa., died July 12. Mr. Saltar was a graduate of the Rensselaer Polytechnic Institute, class '67. Upon graduation he took a position as civil engineer of an eastern railroad and later was appointed city engineer of Saratoga, N. Y. Leaving this position after very satisfactory service he went with the government of Equador in charge of important work. Upon completion of this work he returned to railroad work in the United States and finally accepted a position with the North Chicago Steel Works. Leaving this position in 1881, he became manager of the Western department of the Otto Gas Engine Works, and seven years ago was elected president of the company. Mr. Saltar was the inventor of the type of gasoline engine used in submarine boats throughout the world. He was an active member of the Masonic order and of the Western Society of Mechanical Engineers. His interment took place in Rockford, Ill., the place of his birth.

Chas. E. Tripler, of liquid air fame, died June 20 at Liberty, N. Y., after an illness of several months. Mr. Tripler was born in 1849 and became famous by his production of liquid air and its commercial exploitation. The great expectations raised for liquid air failed to materialize and Mr. Tripler died a somewhat discredited man.

Rufus T. King, who at the time of his retirement in January, 1905, was said to be the oldest railroad engineer, died at Nashua, N. H., May 20. Mr. King was born in Westport, R. I., in 1832, and entered railroad service in 1847 as fireman. He became an engineer in 1849 and remained in almost continuous service until 1905.

* * *

PERSONAL.

Oscar E. Perrigo has taken charge of the shops of the Corwin Mfg. Co., Peabody, Mass.

John D. Webber has been made superintendent of the Auto Weighing Machine Co., Newark, N. J., formerly of Jersey City.

F. A. Curtiss, the Eastern advertising representative of MACHINERY sailed on the *Baltic* July 3 for a month's pleasure trip in the British Isles and on the Continent.

Ned Wheeler, formerly of the University of Kansas, will be instructor in steam engineering at the Case School of Applied Science, Cleveland, Ohio, for the coming year.

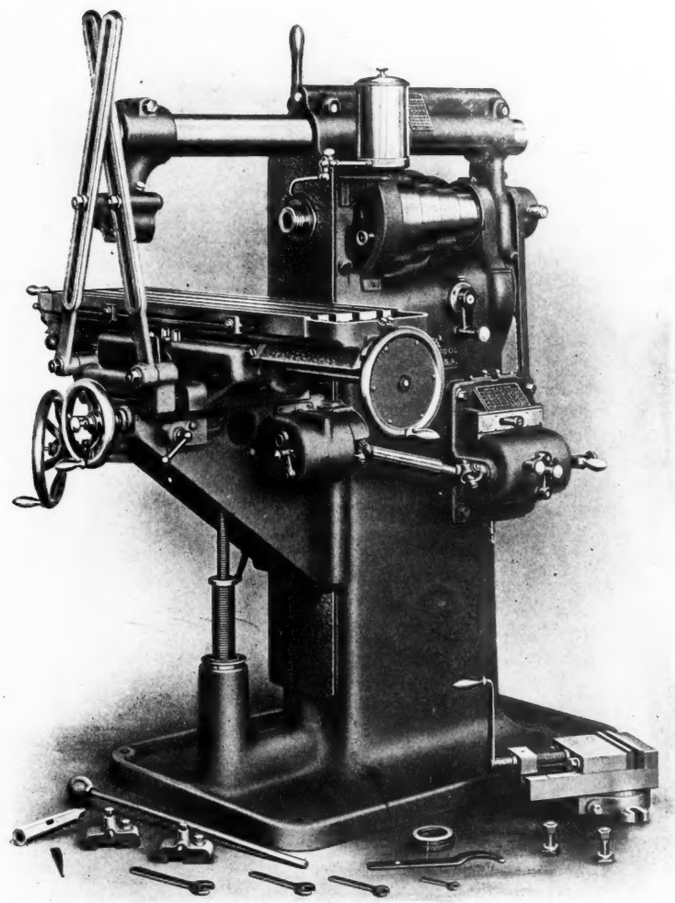
W. D. McKinnon, for the past ten years in charge of the socket department of the Morse Twist Drill Co., New Bedford, Mass., has resigned his position to accept a similar one with the Union Twist Drill Co., Athol, Mass.

BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.

No. 1½ Plain Milling Machine

An addition to our established line of Plain Milling Machines



ILLUSTRATED IN THE CUT

You will note especially the *Extended Knee Slide* rigidly supporting the front spindle bearings, the *Clutched Hand Wheels* and *Clutch Feed Sprocket*, and the *Convenient Location* of *Levers* and all *Working Parts.*

IT IS THE SMALLEST B. & S. BACK-GEARED MACHINE

The gears are located inside the frame and are thrown in and out by a lever on the side of the machine.

Write for a special circular giving a detailed description.

J. Bertram Young has been appointed chemist of the Philadelphia & Reading Railroad Co. vice Robert Job, resigned.

Arthur L. Westcott, assistant professor in the department of mechanical engineering, Case School of Applied Science, Cleveland, Ohio, has resigned to go as assistant professor of experimental engineering with the University of Missouri, Columbia, Mo.

Fred. Perkins and A. P. Lee, of the Perkins Machine Co., Warren, Mass., will sale for Europe August 2d. They will visit England, Scotland, Ireland, Germany, Italy, France, Holland and Belgium to familiarize themselves with the European conditions in regard to presses.

Louis Buschman has been engaged as instructor in gas engineering and automobile practice for the Case School of Applied Science, Cleveland, Ohio. Mr. Buschman recently had charge of an automobile school in connection with the Central Y. M. C. A. of Cleveland.

Howard D. MacDonald, who for several years has been connected with the Deering Works, International Harvester Co., Chicago, went with the J. I. Case Threshing Machine Co., of Racine, Wis., on July 1, as chief draftsman of their tool designing department.

A. L. DeLeeuw, Hamilton, Ohio, a well-known contributor to MACHINERY now engaged in consulting work, is at present engineering the changes and additions to the Hamilton Foundry & Machine Co. of that city. The company is doubling the capacity of its plant and at the same time installing electric drives throughout.

S. J. Berard, formerly a draftsman with the Deane Steam Pump Co., has been taking a course at the Sheffield Scientific School, Yale University, for the past two years, and has been appointed assistant instructor in descriptive geometry and machine design in this institution, the appointment to take effect this fall.

D. E. MacCarthy has been made president and treasurer of the newly organized concern, General Mfg. Co., Elkhart, Ind., manufacturers of bag-making and bag-printing machinery and builders of general machinery contract work. This concern was formerly the New National Mfg. Co. of the same place. Mr. MacCarthy learned the toolmaker's trade with the Wiley & Russell Mfg. Co., Greenfield, Mass., and afterward worked as a toolmaker in several shops, including the Springfield Armory. He then became a designer with the Westinghouse Electric & Mfg. Co., at East Pittsburg, and afterward was put in charge of the detail manufacturing department of that company. Later he became superintendent of the Burroughs Adding Machine Co., St. Louis, Mo., and assisted in the design and arrangement of their new plant at Detroit.

* * *

FRESH FROM THE PRESS.

THE INDICATOR HANDBOOK. By C. N. Pickworth. 130 pages 4¾x7¼ inches, 81 cuts. Published by Emmott & Co., Ltd., Manchester, England, and by D. Van Nostrand Co., New York. Price $1.

This is the third edition of Mr. Pickworth's practical work on the steam engine indicator, its construction and application, errors, methods of attachment, reducing gear, care of the indicator, etc. The book is one that can be recommended unhesitatingly.

POOR'S DIRECTORY OF RAILWAY OFFICIALS (Steam, Electric and Other). 244 pages, 6x9 inches. Published by Poor's Railroad Manual Co., 68 William Street, New York City.

This publication, revised and corrected to Feb. 1, 1906, is a supplement to Poor's Manual of Railroads and contains lists of the officials of all the railroads in operation in the United States, Canada and Mexico on steam, electric and other railroads. In addition are given statistics on steam railroads and of street railroads in which the length of railroads owned, length of railroad operated, capital stock, bonded debt, gross earnings, operating expenses, net income and payments from net income are given for each railroad company.

TRIGONOMETRY SIMPLIFIED. By Chas. Maison. 61 pages 5x7 inches, 28 diagrams. Published by the National Book Co., Cleveland, O. Price 50 cents.

The author says that his aim in preparing this work was "to furnish just so much trigonometry as is actually taught in the schools throughout the world; all investigations of importance both of practical and theoretical work are to be found included." The treatment is of a strictly practical nature and the application of the principles to common problems, many of a mechanical nature, perhaps will make the work of seemingly greater worth to some readers than would the same presentation of the principles in the usual form. The value of a working knowledge of trigonometry to the designer, draftsman and machinist cannot be gainsaid, and if the work in review will assist in overcoming the needless prejudice of many such it is to be commended.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USES IN BUILDING CONSTRUCTION. By H. H. Rice, Wm. M. Torrence and others. 122 pages 6x9 inches. Published by the Engineering Publishing Co., New York. Price $1.50.

This book is made up of articles (and abstracts of same) offered by various competitors who joined in the competition for money prizes of $250 and $100 offered jointly by the *Engineering News* and *Cement Age* of New York City. The two papers which won the prizes are printed in full and the abstracts are parts of ten papers not awarded prizes but which contained data not in the prize papers or which presented the same information in greater length. The articles review the patent situation, the construction of molds, forms of blocks, the relative merits of "wet" and "dry" concrete mixtures, methods of mixing, waterproofing, curing, etc., and a very complete essay on the "state of the art" at the present time. A list of concerns making concrete block machinery is given in an appendix. The growing importance of concrete construction makes the subject of concrete blocks and their use in building construction of great general interest. There is little doubt that the use of concrete in both monolithic and block form will largely displace all other materials of construction within a few years. The scarcity of lumber and its increasing price will virtually force the substitution of other materials, and concrete offers the most practical and the cheapest substitute known. Being fireproof and largely composed of materials found in most localities its use for general building purposes will result in greatly increased permanency of construction and freedom from the destructive fires which is such a standing serious menace to most American cities and towns.

NEW TRADE LITERATURE.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa., 6 x 9 pamphlet, Record of Recent Construction, No. 56, describing the locomotives of the Atchison, Topeka & Santa Fe Railroad System.

ATHOL MACHINE CO., Athol, Mass. New catalogue No. 30 of Vises, Grindstone Frames, Machinists' Tools and other specialties made by the company. The book shows cuts of the various tools and gives tables of specifications, including price lists, for each.

THE INGERSOLL-RAND CO., 11 Broadway, New York City. Catalogue No. 383 of the Temple-Ingersoll Electric-Air Rock Drill. Some new features, construction details, and distinctive features of operation are given as well as descriptions of the tool and its mountings.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. 6 x 9 pamphlet, Record of Recent Construction No. 57, describing the locomotive equipment of the "Associated Lines." The Associated Lines comprise the Southern Pacific, Union Pacific, Oregon Short Line, Oregon Railroad & Navigation Co., and the Chicago & Alton Railways.

THE LUMEN BEARING CO., Toronto, Can., have issued a pamphlet called *The Lumenary*, which they expect to publish monthly. A special feature is the metal report which is a table giving an accurate review of the prices of non-ferrous metals, quotations being taken from the New York daily metal reports.

THE NILES-BEMENT-POND CO., 111 Broadway, New York City, have compiled a list, No. 12, of second-hand metal working machinery. This list groups the various kinds of machinery, *e. g.*, railroad machinery, lathes, drills, etc., and gives a brief paragraph of description of the various types in each.

THE BILLINGS & SPENCER CO., Hartford, Conn. Catalogue of Improved Drop Hammers. Specifications for the hammers are given and various of the parts are shown and described in detail. This firm manufacture a complete line of drop-forged machinists' tools, a catalogue of which will be sent upon request.

LANDIS TOOL CO., Waynesboro, Pa. Catalogue of Landis Grinders. The object of the catalogue is to assist those who are not familiar with grinding machines to understand them and properly care for them. With this in view, the use and operation of the machines are explained and a clear description of the various types is given.

WINDSOR MACHINE CO., Windsor, Vt. Catalogue treating of the Gridley automatic turret lathe. It points out the merits of this machine and its special advantages over other turret machines. A general description of the machine is given and many excellent engravings illustrate the lathe and its various parts, as well as work produced by it.

THE COLBURN MACHINE TOOL CO., Franklin, Pa., have issued an attractive catalogue B concerning the Colburn Universal Saw Table. The words on the front of the cover, "Built Like a Machine Tool," give an idea of the general character of the machine. Complete specifications for all the parts of the machine are given and the book is well illustrated with half-tone engravings throughout.

THE E. W. BLISS CO., 5 Adams Street, Brooklyn, N. Y., have issued a catalogue on "Bliss" machinery for manufacturing electrical parts. The book shows various types of presses, the armature disk-cutting press, the double crank press, the automatic armature disk-notching press, etc., and illustrates on page 52 sheet metal electric parts produced by "Bliss" machinery.

THE GLOBE MACHINE & STAMPING CO., Cleveland, O., are issuing a monthly pamphlet entitled *The Silent Partner*, which is designed to be a medium for taking their patrons and prospective patrons into their business confidence. It contains information concerning the product, plant, etc., of the company. They have also issued a pamphlet entitled, "Do You Tumble?" It contains descriptions and illustrations of horizontal tumblers not hitherto announced.

GISHOLT MACHINE CO., Madison, Wis. Leaflet announcing the purchase of the plant and patents of the American Turret Lathe Co., Warren, Pa., which was effected several months ago. The Warren plant will be used essentially as a manufacturing shop, and all special tools will be built at the Madison plant, where the general offices of the company will be continued. The leaflet gives a brief description of the Warren plant which is one well adapted for manufacturing machine tools. A description of this interesting machine tool shop appeared in the June, 1903, issue of MACHINERY.

CROCKER-WHEELER CO., Ampere, N. J. Bulletin 66 describing class W direct current motors for rolling mill service. These motors are built only for one speed and 220 volts, either series or compound wound, and in four sizes: 25, 50, 75 and 100 horsepower. They are of the inclosed type, and while intended primarily for rolling mill service, are well adapted for any service where a motor is required for heavy intermittent work of a jerky nature. The suggestions of the best mill engineers throughout the country were invited, and utilized in its design. Bulletin No. 67 describes Form I-F variable speed motors and shows a number of machines driven by same.

MANUFACTURERS' NOTES.

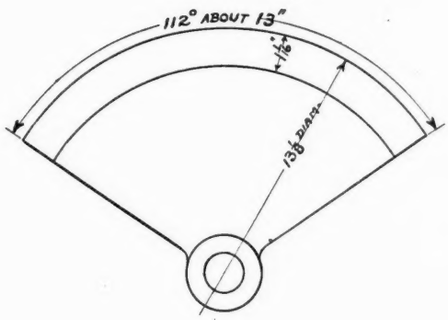
THE CROCKER-WHEELER CO., Ampere, N. J., have sold the Pusey & Jones Co., Wilmington, Del., 33 motors ranging from 1 to 25 H. P. for driving their various ship-building machinery.

THE TRENTON MALLEABLE IRON CO., Trenton, N. J., have entered into the manufacture of gas engines and suction gas producers; the sizes to be built at present are from 30 to 150 H. P., inclusive. Mr. William R. Huttinger is the designer and engineer, and Mr. Frank Peterson is in charge of the sales department.

THE BROWN & SHARPE MFG. CO., Providence, R. I., announce that their works will be closed from August 3 to 13 inclusive for the annual vacation and repairs. The offices will remain open as usual, however, and orders for machine tools, machinists' tools and measuring tools will receive the same attention as at other periods of the year.

THE SPRAGUE ELECTRIC COMPANY announce that it has reopened its office in San Francisco. The former office was destroyed by the earth-

Milling Lathe Work?

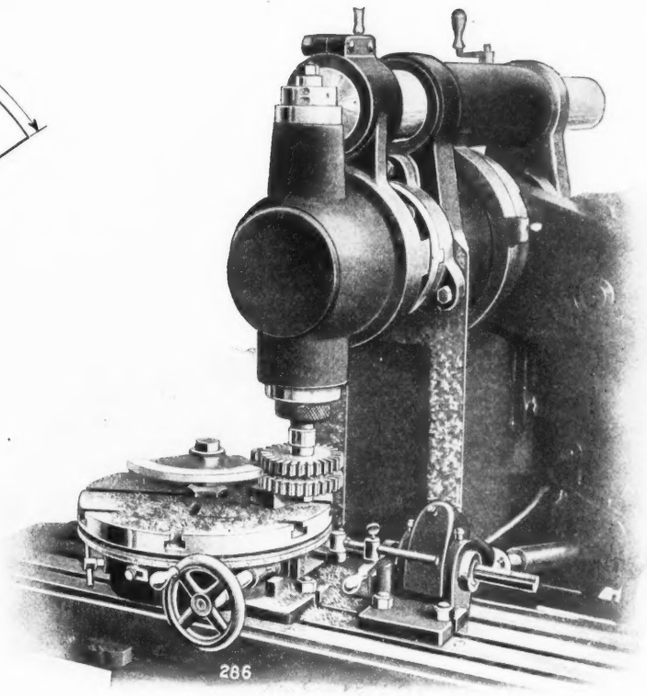


Material: Gray Iron 13⅛" dia., 7-16" thick.

Cut: 1-16" deep.

Cutters: 2" and 6" diameter.

R. P. M.: 45.



Why not, when it saves costs? Of course, it may not pay to put a machine in solely for these odd jobs, but when you can get a standard machine that is at once a horizontal spindle miller, a vertical spindle miller and a circular miller, you have an outfit that will do cheaply and accurately a lot of work on which you are now spending too much time. The illustration shows a

No. 3 Plain Cincinnati Miller

fitted with a Vertical and Circular Attachment, finishing three sides of the pieces shown in the sketch, at one cut in 11½ minutes each, including chucking. This same machine will cut your planer and shaper costs in half.

Get our estimates and suggestions on milling your work,
WE ARE MILLING SPECIALISTS.

The Cincinnati Milling Machine Company

CINCINNATI, OHIO, U. S. A.

European Agents—Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. *Canadian Agents*—Williams & Wilson, Montreal. H. W. Petrie, Toronto.

CONTENTS FOR AUGUST.

THE LUSITANIA 617
BRAKES.—1. C. F. Blake 619
THE FIGURING OF GEAR DRAWINGS. L. D. Burlingame 623
THE IMPORTANCE OF CRYSTALLOGRAPHY IN THE STUDY OF MATERIALS OF CONSTRUCTION 624
SPRING SCREW THREADING DIES. E. Oberg 625
FLOORPLATE WORK IN THE ALLIS-CHALMERS SHOPS 627
THE APPRENTICESHIP QUESTION. Entropy 629
PUNCH AND DIE WORK.—2. E. R. Markham 630
MOTOR DRIVE IN A PROJECTILE SHOP 633
SOME ANNEALING METHODS. E. S. Wheeler 635
LEAD PENCIL MAKING 636
LUNCH ROOM AT THE ROCK ISLAND ARSENAL. A. D. Knauel 637
GLUES AND CEMENTS 638
THE GROWTH OF THE TRADE PAPER 639
EDITORIAL 640
THE EVOLUTION OF THE CORD-KNOTTER OF THE SELF-BINDING HARVESTER 643
ALCOHOL AS A FUEL FOR GAS ENGINES 644
PICKLING CASTINGS 648
CALCULATING CENTRIFUGAL FORCE. W. H. Acker 648
A COUNTRY MACHINE SHOP. R. E. F 649
EXTRUDED METAL SECTIONS 650
WHAT THE POWER HACK SAW CAN DO 651
REPRESENTATIVE AMERICAN MECHANICS AND ENGINEERS. (Samuel Webber) 651
EDO SHOCK ABSORBER 653
FIXTURE FOR SPLINING KEYWAY IN TAPER HOLE OF PINION. I. N. Quire 654
A QUICK-ACTING LOCK FOR THE TAILSTOCK SPINDLE. S. E. Woodbury 654
CUTTING A GEAR IN A LATHE. James McCarthy 655
TRIANGLE FOR DRAWING THREADS. J. W. Coleman 655
TIME SAVING IN DRAFTING ROOM. F. R. Steuart 655
CASTING OUT THE "NINES" TO PROVE MULTIPLICATION AND ADDITION. E. W. Bowen 656
A COMBINATION DRILL JIG WITH MOVABLE LEAVES. L. J. G. 656
SOME TRACING METHODS. F. R. Steuart 656
METHOD OF ENLARGING OR REDUCING DRAWINGS. Winamac 657
SOME DOGS AND DRIVERS. Paul W. Abbott 658
A BROACHING DIE. T. J 659
COMBINATION THREADING TOOL. E. Kneen 659
SHOP KINKS 660
SHOP RECEIPTS AND FORMULAS 661
HOW AND WHY 662
MACHINERY AND TOOLS 663

quake, after which temporary quarters were opened in Oakland. The company is permanently located in the Atlas Building on Mission Street, San Francisco, Cal., where all orders from that territory will receive prompt attention.

AT the election of new officers of the Newton Machine Tool Works, occasioned by the death of Mr. Charles C. Newton, the founder and president of the company, Harry W. Champion was made president; Wm. M. Graham, treasurer; and Ellis J. Hannum, secretary. All these officers have been closely associated in executive positions for many years and no change will be made in the conduct of the business.

THE plant of the Dayton Pneumatic Tool Co., Dayton, Ohio, was damaged by fire July 2d, but we are advised that the injury was comparatively slight, being confined to belting, line-shafting, miscellaneous office supplies, etc. The damage to the power plant made it necessary to close down for a few days until the power plant could be repaired. Operations were to be resumed with full force July 6.

THE TOLEDO MACHINE & TOOL CO., Toledo, O., have secured an order from the United States Government for several presses for one of the navy yards. They have also booked an order for a drop forging plant consisting of one 3,500-pound, two 2,500-pound, two 2,000-pound, two 1,500-pound, and two 1,000-pound drop hammers, and eleven trimming presses ranging in weight from 8,000 to 27,000 pounds.

THE NILES-BEMENT-POND COMPANY and Pratt & Whitney Company have removed their Boston offices from Pearl Street to more spacious and handsomely furnished quarters on the eight floor of the Oliver Building, corner of Milk and Oliver Streets. The policy of these companies is to dispense with showrooms, the variety of both heavy and light machine tools and cranes built by their several works being too great to permit of exhibition.

THE FOOS GAS ENGINE COMPANY, Springfield, Ohio, who have been buying considerable machinery within the last year have again placed an order for $20,000 worth of machine tools, consisting of lathes, planers, boring mills, drill presses, grinders, etc. They find that their present equipment is inadequate to meet the increasing demand for their engines. They have the largest exclusive gas engine factory in the world, having built strictly high grade engines since 1887. They are employing twice as many men in their shops at the present time as they did two years ago.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

A MACHINIST WANTED in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. SMITH CO., Columbia, Pa.

ARE YOU making less than $25 or $30 per week? Mechanical and Structural Drawing taught by experts. Send for circular. Low tuition, including Free Books, Drawing Instruments, Lectures, etc. COLUMBIA CORRESPONDENCE SCHOOL, Drexel Building, Philadelphia, Pa.

COPIES OF MACHINERY wanted for December, 1905, and January, 1906. Address with prices, B., care MACHINERY, 66 West Broadway, New York.

"DIES AND DIE MAKING."—A practical book, $1.00. Send for index sheet. J. L. LUCAS, Bridgeport, Conn.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity, twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DAILY BULLETINS of vacant positions for draftsmen, foremen, engineers, superintendents and salesmen. Stamp. CLEVELAND ENGINEERING AGENCY, Rose Building, Cleveland, Ohio.

"DRAWING AND DESIGN," by Prof. Rogers, gives a complete self-help course in mechanical drawing and design, contains 506 pages, 600 illustrations for practice. Handsomely bound, price $3.00 postpaid. Money refunded if not satisfactory. If interested send for specimen pages free. Write to-day. THEO. AUDEL & CO., 63 Fifth Ave., New York.

DIMENSIONS OF PIPE, FITTINGS AND VALVES, 50 cents. Chapter on Lettering, 25 cents. Our Industrial Magazine, 10 cents a copy. THE BROWNING PRESS, Collinwood, Ohio.

DRAUGHTSMEN.—Mechanical, electrical, structural, architectural, who can do first-class work on the board are at a premium. In a recent issue of "Opportunities," our monthly publication, we listed 104 positions for draughtsmen at salaries of $900-$2,500. There are at least three times that number listed to-day at our twelve offices. Sample copy of "Opportunities" is free for the asking. It may pave the way for large success. Write us to-day. HAPGOODS, 305 Broadway, New York.

FOR SALE.—A slightly damaged Engineering Library, bound in ¾ leather. Ten volumes. Regular price $50.00; will sell for $15.00. Address T. C. P., care Technical World Magazine, Chicago.

FOR SALE.—Cyclopedia of Engineering. Four volumes, bound in half morocco. Slightly damaged. Regular price $18.00. Will sell for $4.00. Address T. C. P., care Technical World Magazine, Chicago.

GENERAL FOREMAN.—Successful in producing first-class work at satisfactory cost, varied experience in high grade machinery, master machinist, desires change. Address Box 71, care MACHINERY, 66 West Broadway, New York.

HELP WANTED.—Competent night foreman over about 20 machine tools, gas engine work. Must be familiar with reduction of costs, have had experience in the handling of men, and between the age of 25 and 40. Chance for promotion if ability is shown. Present salary $3.50 per day. WITTE IRON WORKS CO., Kansas City, Mo.

HELP WANTED.—A competent tool maker familiar with gas engine jigs, templates, etc.; also a competent test floor man. Address Box 72, care MACHINERY, 66 West Broadway, New York.

MACHINE CONCERN desires to acquire rights to manufacture internal combustion engines. Interested parties may address letters Box 75, care MACHINERY, 66 West Broadway, New York.

MACHINISTS WANTED.—We are enlarging our plant, and can use a few first-class machine and bench hands on high-grade work; those having had experience on machine tool work preferred. Our shop is new, well lighted and ventilated and equipped with best machinery. Permanent positions with good opportunities for advancement for steady, reliable men. Madison is an ideal home city; the city is surrounded by lakes with best fishing, boating, etc.; fine schools and libraries; splendid drinking water. A large percentage of our men own their own homes. Write for booklet showing shop and city. Apply in person or by letter to GISHOLT MACHINE CO., Madison, Wis.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge, and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

PETTEY'S PERFECT POCKET PAPER PERFORATOR punches Data Sheets for filing. Always on your key ring. 15 cents each, two for 25 cents. Write now. Agents wanted. J. O. PETTEY, Belvidere, Ill.

SHOP DRAWINGS prepared, and estimates furnished. Shafting, Gear Drives and Special Machinery. Address Box 67, care MACHINERY 66 West Broadway, New York.

THE BUSEY BABBIT MELTER saves time and gas. Send for booklet. BUSY BURNER CO., 23 Clay St., Baltimore, Md.

WANTED.—Worms, Spirals and Screws to cut. We are equipped with special machines for milling these parts. Get our prices on some of your difficult jobs. Address PARSONS & LANE, Sodus, N. Y.

WANTED.—A manufacturer to build machines in the printing line in lots from six to twelve. State full particulars, location, etc. Address Box 64, care MACHINERY, 66 West Broadway, New York.

WANTED.—Accurate draftsmen on Electrical Machinery. Address Box 65, care MACHINERY, 66 West Broadway, New York.

WANTED.—Agents, machinists, tool makers, increase your salary. Sell Saunders' enlarged Hand Book for Practical Mechanics. A pocket-manual guaranteed to fill the bill as a ready reference and to contain more rules, shop kinks, than all the other mechanical books bound together in one volume. Secrets from note books of best mechanics in the country, will figure out by simple arithmetic problems you run up against every day in the shop. Price, postpaid, $1.00 in cloth, $1.25 in leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase Street, Boston, Mass.

WANTED.—First-class machinists, molders and pattern makers, also structural template workers and structural iron workers. We are daily increasing our business and will consider applications from competent mechanics in the above branches of our business. Address, with references, Minneapolis Steel and Machinery Co., Minneapolis, Minn.

WANTED.—Machinist, tool maker, three lathe and two planer hands. State experience and age. SOUTHERN ENGINE & BOILER WORKS, Jackson, Tenn.

WANTED.—By the Bickford Drill & Tool Co., Cincinnati, Ohio, experienced tool maker, vise and scraper hands.

YOUNG, ENERGETIC MAN with several years' experience in handling men and acquainted with modern methods would like position as machine shop superintendent. Address Box 76, care MACHINERY, 66 West Broadway, New York.